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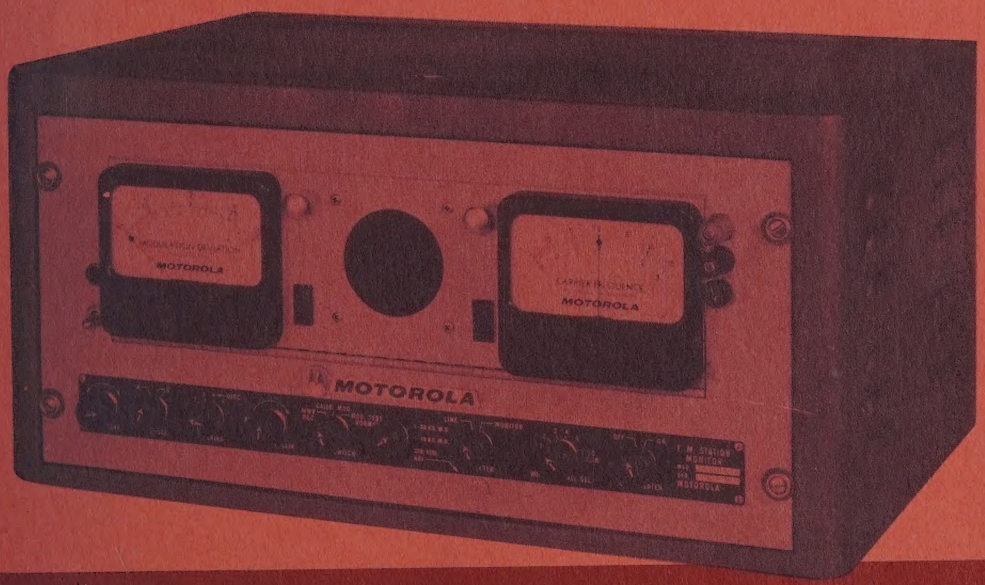
T1130A

MOTOROLA

FM Station Monitor

150-174 MC



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MOTOROLA

FM STATION MONITOR

MODULATION FREQUENCY

CARRIER INDICATION

150-174 MC

117 VAC

MODEL T1130A SERIES FM STATION MONITOR

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INSTALLATION AND OPERATION
MEASUREMENTS
CALIBRATION INSTRUCTIONS
WWV RECEIVER AND CALIBRATING OSCILLATOR
CONTROL RECEIVER
SQUELCH RELAY KIT
POWER SUPPLY

MOTOROLA INC. *Communications Division*

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68P862210
Issue - F

GUARANTEED PERFORMANCE SPECIFICATIONS

MODEL	T1130A	T1132A	T1131A	T1133A
BASIC UNITS	TRD1060A-Calibrating Osc. & 10-15 mc WWV Receiver.		TRD1070A - Calibrating Osc. & 5-10 mc WWV Receiver.	
CONTROL RECEIVER	TRD1080A	TRD1090A	TRD1080A	TRD1090A
FREQUENCY RANGE	150.8-174 mc			
WWV RECEIVER	Contains built-in unit, pre-tuned for reception of 5 & 10 mc or 10 & 15 mc as determined by geographical location of the operating area. Receiver Sensitivity is 5-12 uv.			
PRIMARY POWER SOURCE	117 v a-c 60 cycle			
SPURIOUS RESPONSE	With the monitor circuits peaked on the desired channel, all spurious signals are attenuated at least 35 db.			
FREQUENCY STABILITY	Control receiver frequency can be checked against WWV and adjusted to virtually eliminate frequency stability as a factor in over-all accuracy.			
UNTUNED CHANNEL SENSITIVITY	8 to 2500 microvolts. *			
NOMINAL AUDIO POWER OUTPUT	Approx. 0.5 watt to a 3 ohm speaker at less than 5% distortion.			
POWER SUPPLY RATING	200 v d-c at 60 ma, 6.3 v a-c at 3.5 a			
TUBE COMPLEMENT AND FUNCTION	WWV Receiver & Calib. Osc. 6AK5 RF Amplifier 12AT7 Osc/Mixer 6BE6 Converter 6BJ6 1st IF 6BJ6 2nd IF 6AT6 Det.-AF Amplifier-Oscillator 6AQ5 Power Amplifier OB2 Voltage Regulator Squelch Relay TLN6037A 5963 Relay Control		Control Receiver TRD1080A or TRD1090A 6AK5 1st RF 6AK5 2nd RF 6AK5 1st Mixer 6J6 Osc. & Mult. 6CB6 2nd Mixer 6C4 2nd Osc. 6BH6 2nd IF(1) 6BH6 2nd IF(2) 6BH6 2nd IF(3) 6BH6 2nd IF(4) 6BH6 1st Limiter 6AK6 2nd Limiter 6BG7 Discriminator 6BH6 Noise Amplifier 6BG7 Rectifiers 12AX7 Audio and Squelch 6AK6 Power Amplifier	
ACCURACY**	Modulation deviation can be measured accurately to within ±500 cps at 1000 cycles modulation. Carrier frequency error in the 152-174 mc range is less than ±0.0002%.			
METERING	4-1/2" triple scale microammeter: calibrated in kilocycles for direct reading of carrier frequency error and calibrated in microamperes for relative field strength measurement, on the 15-0-15 scale only 4-1/2" triple scale decibel meter: calibrated in decibels for line level indications and calibrated in kilocycles for direct reading of modulation deviation.			
NOMINAL POWER INPUT (TOTAL)	NORMAL: 50 watts (Monitor Position) CALIBRATE: 65 watts (WWV Receiver on)			
DIMENSIONS	21" wide x 13-1/2" deep x 10-1/2" high overall. Panel designed for standard 8-3/4" x 19" rack mounting.			
WEIGHT	50 lbs complete 56 lbs packed			
INDICATOR LIGHTS	Green Rectangular - Carrier on Red Round - A-C Power on		Red Rectangular - WWV Receiver Power on	

*Sensitivity may be varied over the values shown depending upon the alignment of the monitor circuits.
**Frequency instability error is calibrated out, therefore, does not affect overall accuracy.

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

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MOTOROLA

MODEL CHART

FOR

150.8-174 MC

FM STATION MONITORS

CODE:

[X] = ONE ITEM SUPPLIED WITH RADIO SET

◪ = ONE ITEM SUPPLIED DEPENDENT UPON FREQUENCY COVERED. SPECIFY FREQUENCY WHEN ORDERING.

[N] = NUMBER OF ITEMS DEPENDENT UPON NUMBER OF FREQUENCIES COVERED. SPECIFY FREQUENCIES WHEN ORDERING.

ITEM	DESCRIPTION	REFERENCE DIAGRAM	MODEL NUMBER T1130A	T1131A	T1132A	T1133A
			DESCRIPTION: FM STATION MONITOR, 10-15 MC WWV RECEIVER, 150-170 MC CONTROL RECEIVER	FM STATION MONITOR, 5-10 MC WWV RECEIVER, 150-170 MC CONTROL RECEIVER	FM STATION MONITOR, 10-15 MC WWV RECEIVER, 170-174 MC CONTROL RECEIVER	FM STATION MONITOR, 5-10 MC WWV RECEIVER, 170-174 MC CONTROL RECEIVER
T1060A	10-15 MC WWV RECEIVER & CALIBRATING OSCILLATOR	63E862217	X		X	
T1070A	5-10 MC WWV RECEIVER & CALIBRATING OSCILLATOR	63E862217		X		X
TRD1080A	150-160 MC CONTROL RECEIVER	63E862219	X	X		
TRD1090A	170 MC CONTROL RECEIVER	63E862219			X	X
TLN6037A	SQUELCH RELAY KIT	63B862139	X	X	X	X
TPN6020AA	POWER SUPPLY	63B862133	X	X	X	X
TLN6038A	AC OUTLET KIT	63E862205	X	X	X	X
TGN6001A	FRONT PANEL KIT		X	X	X	X
THN6001A	CABINET KIT		X	X	X	X
TLN6039A	HARDWARE KIT		X	X	X	X
R15	RECEIVER CONTROL CRYSTAL (150, 155, 160 MC)	63E862219	◪	◪		
R38	RECEIVER CONTROL CRYSTAL (170 MC)	63E862219			◪	◪
R11	CALIBRATING OSCILLATOR CRYSTAL	63E862217	X	X	X	X
A07	RECEIVER IF CRYSTAL (8457 KC)	63E862219	X	X		
A18	RECEIVER IF CRYSTAL (8337 KC)	63E862219			X	X
SFMT-2	STATION OSCILLATOR CRYSTAL	63E862217	N	N	N	N

EPD-6765-O

DESCRIPTION

INTRODUCTION

a. Features

Direct-reading measurement of r-f carrier displacement from assigned center frequency. Up to five carrier frequencies in any one band monitored with pre-set crystal controlled circuits. Additional channel monitoring through simple crystal exchange.

Modulation deviation monitoring for both narrow and wideband systems with maximum displacement indication displayed directly in kilocycles.

Oscilloscope connection provisions on front panel for modulation deviation monitoring.

Relative signal strength metering.

High sensitivity allows remote monitoring of mobile units on selected channel.

Automatic limiting eliminates errors due to signal strength variation.

WWV receiver pre-tuned on 5 and 10 mc or 10 and 15 mc, oven type calibration crystal and low frequency test oscillator comprise "built-in" calibration facilities.

Panel mounted speaker for aural monitoring "carrier-on" pilot light indicator, and two 4-1/2" meters for visual monitoring and circuit alignment.

Standard panel size for rack or cabinet mounting. All metal cabinet attractively finished in two-tone grey baked enamel and chrome.

Antennas and additional channel crystals available as accessory items.

b. Design

The Motorola FM Station Monitor is a versatile unit designed to accurately provide operational data pertinent to the operation of frequency modulated transmitters. The functions performed as follows:

(1) Measures carrier frequency deviation from assigned frequency.

(2) Measures frequency modulation of carrier signal.

(3) Measures transmitter relative signal strength.

(4) Provides a special internal precision calibration system which eliminates the usual requirement of a troublesome and costly semi-annual calibration by an approved outside engineering agency.

c. Equipment Components

The complete unit consists of the following five basic components:

(1) Control Receiver TRD1080A or TRD1090A

The TRD1080A Control Receiver is a 17 tube, double conversion superheterodyne, strip-type receiver chassis designed for reception of FM signals in the 150-160 mc range.

The TRD1090A Control Receiver is a 17 tube, double conversion superheterodyne, strip-type receiver chassis designed for reception of FM signals in the 170 mc range.

(2) WWV Receiver and Calibrating Oscillator (TRD1060A or TRD1070A)

(a) WWV Receiver -- The WWV receiver is an AM superheterodyne receiver designed for the reception of Primary Standard signals from radio station WWV, Washington, D.C. The WWV receiver is supplied with either a 5 and 10 mc coil kit or a 10 and 15 mc coil kit. The coil kit selected depends upon the locality where the frequency monitor is to be used: 5 and 10 mc for areas East of the Mississippi, 10 and 15 mc for areas West of the Mississippi, or customer preference.

(b) Calibrating Oscillator -- The calibrating oscillator consists basically of an r-f amplifier stage, a mixer, and an oscillator. A selector switch provides the oscillator with any one of six crystals as the frequency controlling element. One of these crystals is a calibrating crystal, which is shunted by a trimmer capacitor for any minor adjustment of oscillator frequency. This crystal is used for calibrating the control receiver. The use of the five channel crystals is discussed in the Installation and Operation Section of this manual.

Another outstanding feature of the calibrating oscillator is the high degree of accuracy of the calibrating crystal when calibrated with the use of the WWV Receiver. Although the crystal is temperature controlled, a GREATER DEGREE OF ACCURACY IS OBTAINABLE WITHOUT THE USE OF THE HEATER. The trimmer capacitor, STD XTAL ADJ, provides EXACT calibration of the crystal frequency at any temperature by zero beating the oscillator against the primary standard WWV signal.

The crystal heater should be used ONLY when a quick check is necessary; such as, where it is desired to quickly bring the crystal to a temperature that would eventually be reached due to the heat dissipation of the equipment.

(3) Power Supply (TPN6020AA)

The TPN6020AA Power Supply furnishes all the necessary operating voltages for the station monitor equipment. A full wave selenium rectifier supplies B+ to the Control and WWV receivers and the calibrating oscillator. A filament transformer supplies 6.3 volts to the filaments and indicator lamps.

(4) Squelch Relay (TLN6037A)

The TLN6037A Squelch Relay is controlled by a sensitive electronic circuit and is used to provide a visual indication of a received carrier.

(5) Bracket Assembly

The Bracket Assembly consists of a High Recovery (H.R.) Discriminator, Modulation Deviation Control, and H.R. Discriminator Slope Adjust Control (factory adjusted and locked) to provide a more accurate monitoring of narrow band channel spacing.

d. Mounting

The Calibrating Oscillator & WWV Receiver, the Control Receiver, and the Power Supply are each mounted on a strip-type chassis. The frequency monitor is supplied complete in an attractive all-steel housing designed for table-top installation. The complete equipment is attached to the cabinet front panel so that it can be installed in standard 19" vertical rack if desired.

INSTALLATION AND OPERATION

1. INSTALLATION

a. Inspection

Inspect the equipment thoroughly as soon as possible after delivery. If any part of the equipment has been damaged in transit, report the extent of the damage to the transportation company immediately.

b. General

Only four connections are required to install the Motorola Frequency Monitor. These are as follows:

(1) Connect a low frequency antenna to the WWV antenna connector. A suggested method for erecting a WWV antenna has been included in this manual (Refer to Diagram 69B801301).

NOTE

The WWV antenna input circuit has two antenna connectors, each having a different input impedance. The connector designated LZ should be used with coaxial lines and low impedance antennas. The connector designated HZ should be used with long wire, or high impedance antennas. A cinch type male connector is provided for connecting the antenna lead-in to the LZ or HZ connector.

(2) Connect a vhf antenna to the Monitor coaxial-type antenna connector. A male coaxial plug is supplied for connecting the antenna lead-in to the VHF ANT feed-thru connector.

NOTE

The main station antenna may be used as the frequency monitor vhf antenna if slightly reduced station receiver sensitivity will not affect operation of the communication system. Refer to Diagram 69B801301.

(3) Make a suitable external ground connection to the Frequency Monitor chassis.

(4) Connect the a-c power cord to a 117 v a-c, 60 cycle power source.

2. OPERATION

a. Front Panel Control Switches & Indicators and Their Functions

(1) The round RED lamp is the a-c power indicator.

(2) The ON-OFF switch turns the a-c power "on" or "off".

(3) The rectangular RED lamp indicates WWV receiver is "on".

(4) The GREEN lamp indicates that a strong carrier signal has opened the control receiver squelch circuit.

(5) CARRIER FREQUENCY Meter: Used to indicate carrier frequency error, relative signal strength, and control receiver circuit readings. The meter is calibrated in kilocycles and microamperes. When used in conjunction with the METERING switch, this meter can be used as a test meter for touch-up alignment of the UNI-CHANNEL Control Receiver.

(6) MODULATION DEVIATION Meter is used to indicate carrier deviation due to modulation.

Used also for calibration of audio amplification. The meter is calibrated in db and kilocycles.

(7) The WWV TUNE Control tunes WWV receiver oscillator circuit.

(8) The WWV SEL Switch selects the WWV frequency.

TRD1060A WWV Receiver & Calibrating Oscillator:

POS. A	15 mc
POS. B	10 mc

TRD1070A WWV Receiver & Calibrating Oscillator:

POS. A	5 mc
POS. B	10 mc

(9) The METERING Switch connects CARRIER FREQUENCY meter to the following circuits of Control Receiver:

POS. 1	2nd IF Grid
POS. 2	1st Limiter Grid
POS. 3	2nd Limiter Grid
POS. 4	Discriminator Balance
POS. 5	Discriminator Plate
POS. 6	2nd Multiplier Grid

(10) The WWV-AF GAIN Control varies gain of the WWV receiver audio amplifier. Also varies output of the audio oscillator.

(11) The CALIBRATION Switch controls operation of WWV Receiver and Control Receiver as follows:

(a) WWV REC Position

1. Connects WWV detector output to WWV audio amplifier.

2. Connects WWV amplifier to the speaker or MODULATION DEVIATION meter, depending upon the position of the DB METER switch. With the DB METER switch in the MONITOR position the WWV audio amplifier is connected to the MODULATION DEVIATION meter by means of the control receiver output transformer.

3. Connects B+ to the r-f section of the WWV receiver.

(b) CALIB MOD position

1. Inserts anr-c feedback network into the 1st audio amplifier (V-4) of the WWV receiver causing the amplifier to operate as an audio oscillator.

2. Connects the audio oscillator output to the speaker or MODULATION DEVIATION meter depending upon the position of the DB METER switch.

(c) MOD TEST NORMAL position

1. Inserts an r-c feedback into the 1st audio amplifier (V-4) of the WWV receiver causing the amplifier to operate as an audio oscillator.

2. Connects the audio oscillator output to the audio input of the control receiver.

3. Connects B+ to the screen grid of the control receiver power amplifier tube.

(12) STD XTAL ADJ varies the trimmer capacitor of the 5 mc. calibration crystal.

(13) SELECTOR Switch

(a) 0-20 KC. M.D. position

1. Connects Modulation Deviation Control into metering circuit.

2. Modulation Deviation Meter readings on 0-20 KC. range.

3. Carrier Frequency Meter readings on 15-0-15 KC. or microamperes.

(b) 0-10 KC. M.D. Position

1. Connects the High Recovery Discriminator into the Carrier Frequency Meter circuit.

2. Modulation Deviation Meter readings on 0-10 KC. range.

3. Carrier Frequency Meter readings on the 3-0-3 KC. range.

(14) DB METER Switch

(a) LINE Position

1. Connects the WWV receiver output to the speaker (CALIBRATION switch in WWV REC position).

2. Connects the control receiver output to the speaker (CALIBRATION switch in MOD TEST NORMAL position).

(b) MONITOR position

1. Connects the WWV receiver output to the MODULATION DEVIATION meter (CALIBRATION switch in WWV REC position).

2. Connects the control receiver output to the MODULATION DEVIATION meter (CALIBRATION switch in MOD TEST NORMAL position).

(15) The XTAL HEATER turns the 5 mc calibration crystal heater "on" or "off".

NOTE

Use crystal heater only when the calibration crystal is subjected to extremely low temperature or when a quick check is necessary.

(16) The MON CHANNEL SEL switch positions 1 through 5 select the channel crystal frequency to be used for mixing with the monitored carrier frequency. DISC CALIB position connects the 5 mc. calibration crystal into the oscillator circuit.

(17) The Zero Set Control is used to balance the control receiver discriminator.

b. Internal Controls and Their Functions

(1) The SLOPE control is an internally located factory adjusted control which is locked in position. This control is used to set the slope of the control receiver discriminator and is not to be changed.

(2) The VOLUME Control controls audio gain of the control receiver. This control is preset at the factory. If adjustment is necessary, refer to the Audio Gain Calibration instructions in this text.

(3) The SQUELCH Control determines the level at which the squelch opens.

(4) On the Bracket Assembly:

(a) The MODULATION DEVIATION control adjusts the modulation deviation reading to obtain full scale deflection at 20 kc modulation.

(b) The SLOPE ADJUST Control is a factory adjusted control which is locked in position. This control is used to set the slope of the High Recovery Discriminator and is not to be changed.

(c) The ZERO ADJUST Control adjusts the High Recovery Discriminator to zero.

(d) The SPEAKER Gain controls speaker output level.

c. Pre-Operational Checks and Adjustments

(1) General

The Frequency Monitor has been properly tuned and adjusted prior to shipment from the factory. However, due to the possibility of mishandling while in transit, the control receiver should be checked for proper gain and sensitivity as follows:

(a) Mechanically adjust the CARRIER FREQUENCY and MODULATION DEVIATION meters to read zero. The mechanical adjustment screw is located on the front of each meter.

(b) Turn the ON-OFF switch to the ON position. The round red indicator light above the switch should become illuminated.

(c) Turn the MON CHANNEL SEL switch to the DISC CALIB position. After a short control receiver warm-up period the green indicator light should become illuminated.

(d) Turn the SELECTOR switch to the 0-20 KC. M.D. position.

(e) Place the METERING switch in position 1.

(f) The CARRIER FREQUENCY meter should indicate 1/2 microampere or more right meter deflection.

(2) Squelch Adjustment

(a) Turn the DB METER Switch to the LINE position.

(b) Turn the CALIBRATION switch to the MOD TEST NORMAL position.

(c) Turn the SQUELCH control, located on the control receiver, fully counterclockwise. Make sure that no signal is present so that noise only will be heard. The green indicator lamp should become illuminated.

(d) Turn the SQUELCH control fully clockwise. The noise should be squelched (cut out) and the light in the green indicator lamp should go out.

NOTE

The SQUELCH control should not be adjusted to the normal threshold setting in monitor application.

d. Principle of Operation

(1) General

The frequency monitor operates on the heterodyne principle. A station frequency is monitored by heterodyning its carrier with the output frequency of the crystal oscillator and then feeding the resultant frequency of these two signals into the calibrated control receiver. If the beat frequency between the crystal oscillator signal and the monitored carrier is exactly equal to the frequency to which the receiver is aligned, the CARRIER FREQUENCY meter will indicate zero, i.e., no reading. If the beat frequency is lower or higher in the frequency than the one to which the receiver is aligned, a direct indication of carrier frequency error in the monitored transmitter will be given on the CARRIER FREQUENCY meter.

In standard applications, the control receiver is aligned to one of four pre-determined frequencies. The specific frequency used will depend upon the spurious harmonics emitted by the channel crystals which will be required to monitor the specific carrier channels in consideration.

The beat frequency which is fed to the control receiver may be either the sum or difference frequency of the channel crystal frequency and the monitored carrier frequency. Channel crystals are available for operation in the range from approximately 1.6 mc to 12.5 mc. However, in some monitors where it is desired to monitor 5 station frequencies with a control receiver aligned to a given frequency, it will be necessary to produce a difference frequency above 12.5 mc. In this case a channel crystal, the second harmonic of which may be beat against the monitored carrier to produce the frequency of the control receiver, should be used. Use of the second harmonic of the channel crystal introduces no appreciable error in monitoring accuracy.

NOTE

When using the preceding method for selecting a channel crystal, it is important that the crystal be checked for interference to the control receiver before making a final decision as to the application. If any harmonic of the channel crystal falls within 120 kc. of the control receiver frequency, interference may result, therefore, the crystal cannot be used. In this case, the control receiver should be re-aligned and a new channel crystal which will not cause interference to the new control receiver frequency selected. Note however, that re-alignment of the receiver to a new control frequency will not permit use of other channel crystals previously calculated for the old frequency, without re-alignment to the old frequency.

(2) Calibration Oscillator

The frequency monitor includes a temperature compensated crystal oscillator which is adjusted to oscillate on frequency by checking its output frequency against the standard signal from Radio Station WWV. The oscillator is then used to calibrate the control receiver, i.e., adjust the control receiver discriminator, and the High Recovery Discriminator outputs for a zero reading on the CARRIER FREQUENCY meter.

The control receiver operates in the 150-170 mc. range, therefore, when using a 5 mc calibration crystal, the 30th, 31st, 32nd, or 34th harmonic of the 5 mc crystal frequency must be used to calibrate the receiver to 150, 155, 160, or 170 mc.

The MON CHANNEL SEL switch operates in conjunction with the calibrating oscillator. This switch may be used to select any one of six crystals as the frequency controlling element of the oscillator. These crystals include the 5 mc. calibration crystal and the five channel crystals.

One half of a 12AT7 tube is used as the oscillator while the other half of the tube functions as the mixer. The carrier frequency to be monitored is picked up by the VHF antenna, amplified by the 6AK5 RF amplifier, and then fed to the mixer where it is "mixed" with the selected channel crystal frequency. The output of the mixer is fed to the calibrated control receiver where it is determined if the transmitted carrier is on frequency.

(3) Carrier Frequency Monitoring Example

(a) 150.8-174 MC

Assume that it is desired to monitor the output of the transmitter which is operating on

152.45 mc and that the control receiver has been calibrated at 150 mc. The necessary channel crystal frequency will be the difference between 152.45 mc and 150 mc or 2.45 mc. If the transmitter is "on" frequency the 152.45 mc signal will mix with the 2.45 mc channel crystal frequency to produce an input signal of 150 mc at the control receiver. In this case, no indication will be given by the CARRIER FREQUENCY meter. If the monitored transmitter carrier is above or below its designated frequency, the input signal to the control receiver will be above or below 150 mc, causing the discriminator to produce an output voltage. This voltage is fed to the CARRIER FREQUENCY meter which is calibrated in kilocycles to give a direct reading of carrier frequency error.

(b) 450-470 MC

When monitoring transmitters which operate in the 450-470 mc band, the monitor must be placed so that the monitor antenna is within a few feet of the transmitter. For this application, the frequency of the stage preceding the final tripler is monitored. This is done by selecting a difference frequency crystal for the monitor which, when "beat" against the frequency of the transmitter stage preceding the tripler, produces the frequency at which the control receiver is tuned.

Assume that it is desired to monitor the output of a transmitter which is operating on 453.750 mc and that the control receiver is calibrated at 160 mc. The channel crystal frequency is determined as follows:

$$\frac{453.750 \text{ mc}}{3 \text{ (tripler)}} = 151.250 \text{ mc (frequency actually monitored)}$$

$$160.000 \text{ mc} - 151.250 \text{ mc} = 8.75 \text{ mc (channel frequency crystal)}$$

If the transmitter is "on" frequency the frequency of the stage preceding the final tripler will mix with the 8.75 mc channel crystal frequency to produce an input signal of 160 mc at the control receiver. In this case, no indication will be given by the CARRIER FREQUENCY meter. If the monitored transmitter carrier is above or below its designated frequency, the input signal to the control receiver will be above or below 160 mc, causing the discriminator to produce an output voltage. This voltage is fed to the CARRIER FREQUENCY meter which is calibrated in kilocycles to give a direct reading of carrier frequency error.

Any error in carrier frequency indicated on the CARRIER FREQUENCY meter is an error in the frequency of the stage preceding the tripler, therefore, the error in the transmitter signal from the final amplifier will be three times as great. When using this method of monitoring, check the output (450-470 mc) of the transmitter with a reliable wavemeter to ascertain that proper frequency multiplication is made.

(4) Channel Crystal Accuracy

Since the fundamental frequency of the channel crystals is used, any error in crystal frequency is not multiplied. Therefore, the error in monitoring a frequency by this method is very small. Crystals are held to within 0.002% of the specified frequency over the ambient temperature range of -30°C to +60°C. Therefore, with the previous example, the maximum frequency error of the 2.45 mc crystal would be 2.45 mc x 0.0020% or 49 cycles. At the frequency being monitored the percentage error would be 49/152.45 mc x 100 or approximately 0.000032%. This amount of error is not discernible on the meter.

The "improvement factor" of possible percentage accuracy at the channel crystal frequency over the percentage accuracy at the carrier frequency is approximately the same ratio as the monitored carrier frequency over the channel crystal frequency. Hence, 0.0020/0.000032 equals 62.5 and 152.45/2.45 equals 62.2. This is another way of stating that the channel crystal is more than 62 times as good percentage-wise at the monitored frequency than at its fundamental frequency.

The improvement factor may be checked on any channel by the above method. It will always remain reasonably high, therefore, the possible error of the channel crystal frequency is negligible.

The actual channel crystal frequency, after grinding and setting, is measured and shown on the calibration tag attached to the frequency monitor. The probable or anticipated frequency variation may be directly added to or subtracted from the carrier frequency but will be found to be completely negligible in all cases.

(5) Relative Signal Strength

Relative signal strength is measured by observing the control receiver limiter grid voltreadings. This is position 1, 2 or 3 on the

METERING switch. This reading should then be compared with readings logged while other transmitters on the same channel were transmitting. The comparison of these readings will give an indication of relative signal strength.

(6) Audio Gain Calibration For Deviation Measurement

NOTE

Calibration should always be made with the SELECTOR switch in the 0-10 KC. M.D. position, leaving the MOD. DEV. control out of the metering circuit.

The audio amplification of the control receiver may vary with the age of the equipment, tube replacement, climatic change, or for other reasons. To compensate for these variations that may occur, the audio amplification of the control receiver is calibrated; thereby providing an unusual degree of additional accuracy in the measurement of carrier deviation under modulated conditions.

This audio amplification of the control receiver is calibrated by means of an audio frequency oscillator which is incorporated in the WWV receiver. The CALIBRATION SWITCH, when placed in the CALIB MOD or the MOD TEST NORMAL position, inserts an RC network between the plate and grid of the first audio stage (V-4) of the WWV receiver. The insertion of this network causes V-4 to act as an audio oscillator.

The output level of the audio oscillator is metered by the MODULATION DEVIATION meter on the front panel of the monitor. The output level is set to a specific value through the use of the WWV receiver GAIN control. This specified output level is indicated on a calibration data tag attached to the monitor.

NOTE

A calibration curve is not necessary for operation of the Frequency Monitor.

The output of the audio oscillator is connected to the control receiver audio amplifier by placing the CALIBRATION switch in the MOD TEST NORMAL position. The output of the control receiver amplifier can be read on the MODULATION DEVIATION meter. The amplifier gain can be corrected by adjusting the VOLUME control on the control receiver until the meter reads correctly.

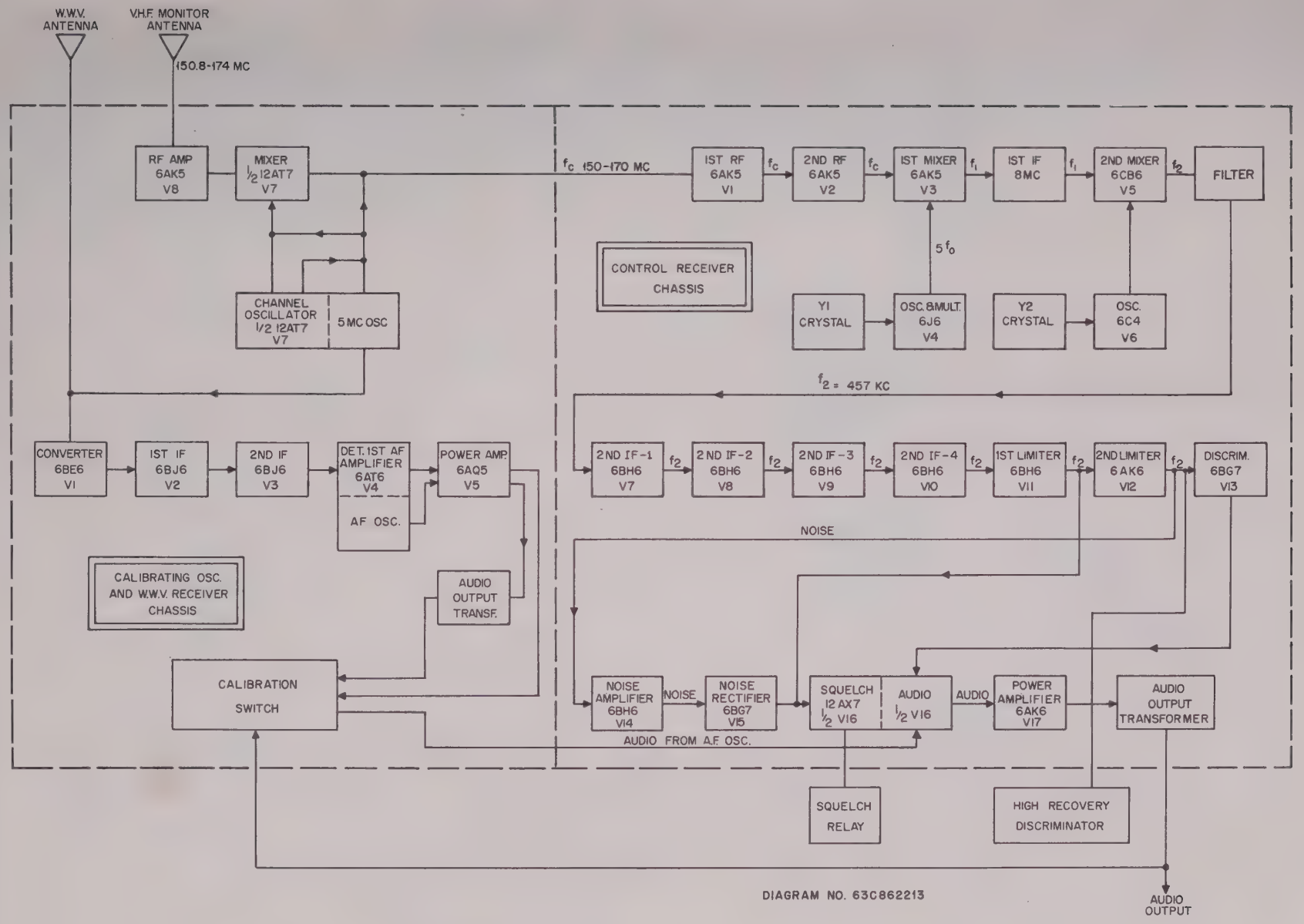
After calibration, the modulation of the monitored transmitter may be read directly in kilocycles on the MODULATION DEVIATION meter which is connected across the output of the control receiver when the DB METER switch is in the MONITOR position.

(7) Line Level Monitoring

Additional provisions have been made whereas the FM Station Monitor may be used to measure audio line level to the transmitting equipment.

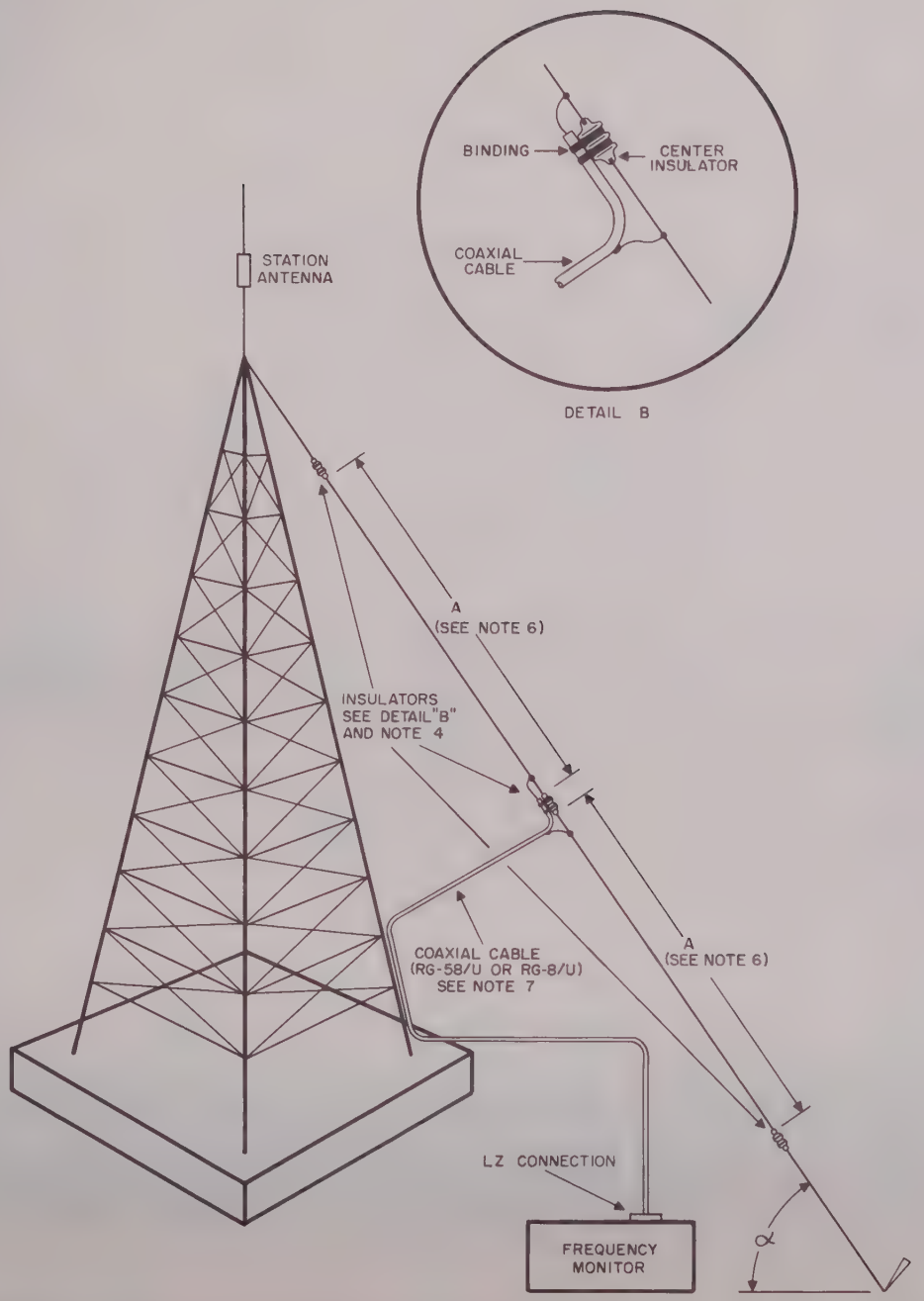
Tap off the audio input lines and make permanent connections to pins 6 and 7 of the front panel connector (P-2).

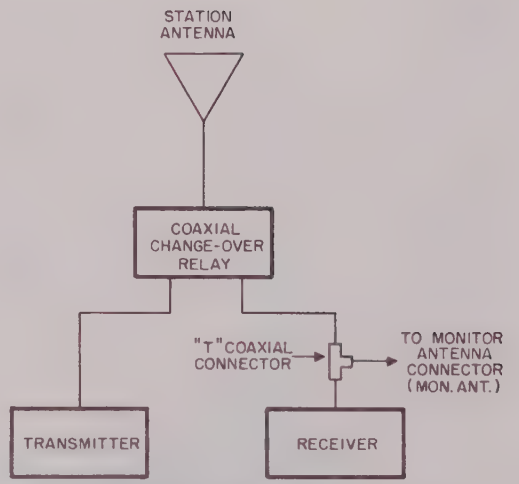
Place the DB METER Switch in the LINE position, and read the line level on the DB scale of the MODULATION DEVIATION Meter.



150-174 MC FM Station Monitor
Block Diagram
Motorola No. 63C862213-A
10/13/61-RCS

FM Station Monitor
Antenna Systems Detail
Motorola No. 69C80130l-B
10/25/59-RCS





STATION ANTENNA USED AS FREQUENCY MONITOR VHF ANTENNA.

NOTES:

1. THE ANTENNA MAY BE SUPPORTED BY UTILIZING THE STATION ANTENNA TOWER OR OTHER HIGH STRUCTURE. THE ANGLE OF THE WWV ANTENNA (α) IS NOT CRITICAL.
2. ERECT ANTENNA IN A NOISE FREE AREA, AWAY FROM ELECTRICAL MOTORS OR OTHER ELECTRICAL MACHINES CREATING ELECTRICAL INTERFERENCE.
3. FOR BEST WWV RECEPTION, PLACE ANTENNA AS HIGH AS POSSIBLE AND IN THE OPEN.
4. SECURE COAXIAL CABLE TO CENTER INSULATOR TO PREVENT BREAKAGE.
5. WIRE MUST BE #12 GAUGE OR LARGER TO WITHSTAND WIND & ICE LOADING.
6. FOR 5MC, 10MC, & 15MC, LENGTH A IS 48 FEET.
7. COAXIAL CABLE LENGTH – ANY ODD 1/4 WAVELENGTH AT 10MC. SEE TABLE.

10MC ODD 1/4 WAVELENGTHS

16 FT	144 FT	272 FT
48 FT	177 FT	304 FT
80 FT	208 FT	336 FT
112 FT	240 FT	

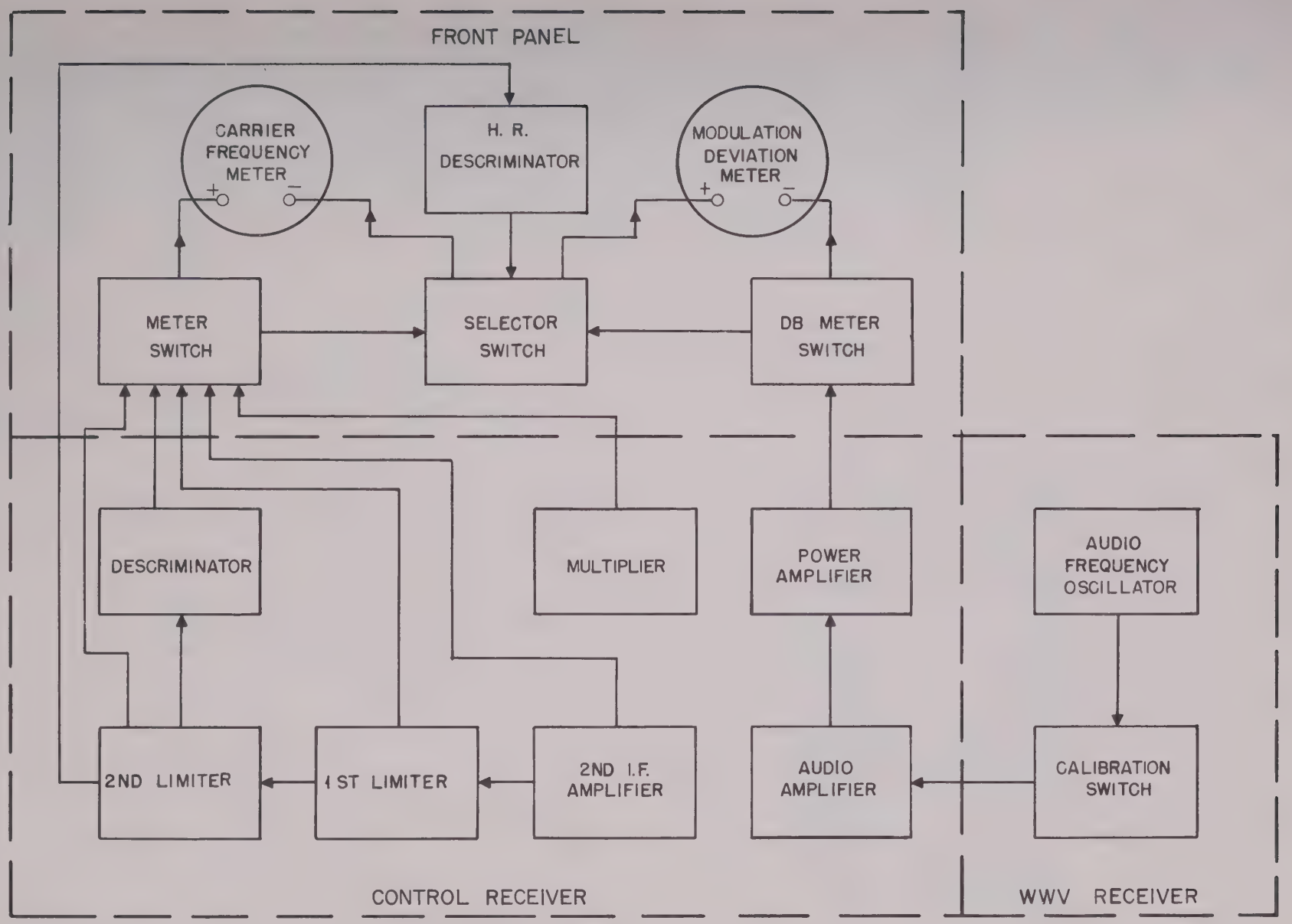
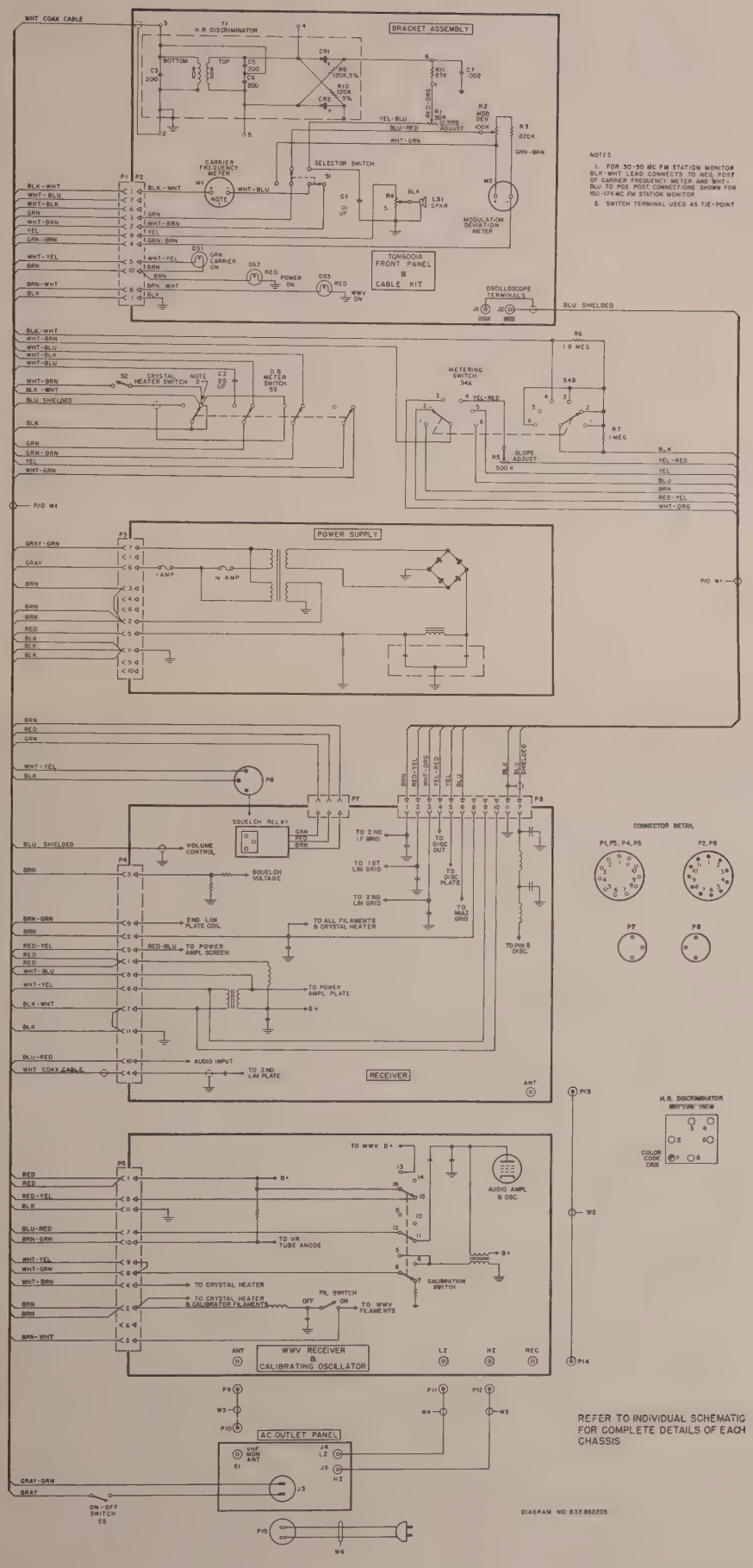


DIAGRAM NO. 69B862214

Metering Block Diagram
Motorola No. 69B862214-O
10/25/59-RCS



MODEL TABLE

MODEL	SUFFIX	DESCRIPTION
TGN6001A	4	FM STATION MONITOR

REVISIONS

DIAG. ISSUE	CHASSIS SUFFIX	REF. SYMBOL	CHANGE	LOCATION
A	TGN6001A-2	M2	WAS 5282R1352	FRONT PANEL
B & C		S3	CHANGED FROM DB METER SWITCH (S3) REVISED	FRONT PANEL METER SWITCHING CABLE
D	TGN6001A-3		RESISTOR ADDED TO CONTACT (7) ON CALIBRATION SWITCH	WWV RECEIVER
E		C2	.01 µF ADDED	H.R. DISCR.
		R11	27K ADDED	ON FRONT
F	TGN6001A-4	R8	NOT INSTALLED REMOVED (6.8K)	PANEL

FM Station Monitor
Intercabling Diagram
Motorola No. 63E862205-F
10/13/61-RCS

PARTS LIST for Intercabling Diagram 63E862205-F

REFERENCE SYMBOL	MOTOROLA PART No	DESCRIPTION
		CAPACITOR, fixed:
C1	21B801139	ceramic, disc, .01 uf +80-20%, 600 vdcw
C2	8B891877	oil filled, tubular, .25 uf +100-10% 1000 vdcw
C3	21K840812	dipped silver mica; 200 uuf ±5%; 500 vdcw
C4		NOT USED
C5		same as C3
C6		same as C3
C7	21K855384	cer. disc; .002 uf±15%; 250 vdcw
		CRYSTAL UNIT, rectifying:
CR1	48B859024	silicon junction; type HD6637
CR2		same as CR1
		LAMP, incandescent:
DS1	65R11854	6.3 volt; .15 ampere; miniature single contact bayonet base; tubular glass; type #47
DS2		same as DS1
DS3		same as DS1
		ADAPTER, connector:
E1	58A475273	female; single contact feed-thru
		CONNECTOR, receptacle:
J1	46B861855	female; single contact; molded black phenolic post type; chassis mounted; includes 14K861856 INSULATOR and two 10-32 hexagon mounting nuts
J2	46K861857	female; single contact; molded red phenolic post type; chassis mounted; includes 14K861858 INSULATOR and two 10-32 hexagon mounting nuts
J3	28A893223	male; 2 a-c contact; round molded black bakelite base; does not include 42A821428 RING, connector retainer; ring must be ordered separately
J4	9C87120	female; single contact; round molded mica filled phenolic insulator; chassis mounted
J5		same as J4
		SPEAKER, magnetic:
LS1	50B470620	voice coil impedance; 3.2 ohm; 3-1/2"
		METER, multi-scale:
M1	52K863460	dual scale; 15-0-15 kc and 3-0-3 ua; CARRIER FREQUENCY
M2	72C86375Z	triple scale; 0-20 kc; 0-10 kc and -10-0+6 db; MODULATION DEVIATION
		CONNECTOR, plug:
P1	9C86864	female; 11 contact; polarized; round molded black plastic insulator; cable mounted; does not include 15A483149 SHELL, connector; shell must be order ordered separately
P2	28B813576	male; 11 contact; polarized; round molded black phenolic insulator; cable mounted; does not include 15A483149 SHELL, connector; shell must be ordered separately
P3		same as P1
P4	9C86864	female; 11 contact; polarized; round molded black plastic insulator chassis mounted; does not include 42A821428 RING,

REFERENCE SYMBOL	MOTOROLA PART No	DESCRIPTION
		CONNECTOR, plug: (cont'd) connector retainer, ring must be ordered separately
P5		same as P4
P6	28A16313	male; 3 contact; polarized; round bakelite wafer insulator; cable mounted, does not include 15K801256 SHELL, connector, shell must be ordered separately
P7	9A840673	female; 3 contact; polarized; round bakelite wafer insulator; cable mounted; does not include 15A840674 SHELL, connector; shell must be ordered separately
P8	28B813576	male; 11 contact; polarized, round molded black phenolic insulator; cable mounted; does not include 15A83157 SHELL, connector; shell must be ordered separately
P9	28A474006	male; single contact; round bakelite wafer insulator; cable mounted
P10	28C42310	male; single contact; round mica filled phenolic insulator; cable mounted; does not include 54K854020 ADAPTER, coaxial cable; adapter must be ordered separately
P11		same as P9
P12		same as P9
P13		same as P9
P14		same as P9
P15	9A893224	female; 2 a-c contact; round molded black bakelite insulator; cable mounted; does not include 15A483149 SHELL, connector and 41A483715 SPRING, connector shell retainer; shell and spring must be ordered separately
		RESISTOR, fixed: carbon; unless otherwise stated
R1	18K863100	variable; 50K ±20%; .2 w
R2	18K855906	variable; 100K ±20%; .2 w
R3	6R6429	820K ±10%; 1/2 w; ins.
R4	18A82851	variable; wire-wound; 5 ohm
R5	18K893205	variable; 500K ±20%; 1/4 w
R6	6R488215	1.8 megohm ±10%; 1/2 w; ins.
R7	6R6046	1 megohm ±10%; 1/2 w; ins.
R8		NOT USED
R9	6R2049	120K ±5%; 1/2 w; ins.
R10		same as R9
R11	6R6434	27K ±10%; 1/2 w
		SWITCH,
S1	40K863031	rotary: 2 pole; 2 position
S2		same as S1
S3	40K893209	rotary: 4 pole; 2 position
S4	40K893208	rotary; 2 pole; 6 position
S5	40A482097 or 40A811826	toggle: spst
		TRANSFORMER,
T1	1V863475	discriminator: includes two 76A821495 CORE, adjustable tuning; coded YELLOW dot and reference parts C3, C4, C5, C6, CR1, CR2, R8, R9, R10
		CABLE ASSEMBLY, special purpose:
W1	1V863478	Control and Metering; includes 1V863479 Laced Cable and

REFERENCE SYMBOL	MOTOROLA PART No	DESCRIPTION
		CABLE ASSEMBLY, (cont'd) reference parts P1, P3, P4, P5, P6, P7, P8, R5, R6, R7, S1, S2, S3, S4, S5
		LINE, RF transmission:
W2	1K800430	includes 30B475378 CABLE, R-F: coaxial; RG-58A/U; 20-1/2" length required and reference part P13, P14
W3	1K800431	includes 30B475378 CABLE, R-F: coaxial; RG-58A/U; 24" length required and reference parts P9, P10
W4	1V893231	includes 30B475378 CABLE, R-F: coaxial; RG-58A/U; 8" length required and reference part P11
		CABLE ASSEMBLY, special purpose:
W5	1V800409	includes 10M9119 WIRE, electrical: single conductor; #20 ga. str.; ins.; coded WHT-BLK; 8" length required and reference part P12
W6	1V893228	includes 30B892534 CABLE, two conductor; #18 ga. str.; ins.; coded WHT and BLK, with two a-c contact connector; and reference part P15
		LAMPHOLDER:
XDS1	60A20781	miniature single contact bayonet base with insulated mounting clip; does not include 41A472538 SPRING, lamp backing and 43A472539 INSULATOR and CONTACT EYELET; spring and insulator and contact eyelet must be ordered separately
XDS2		same as XDS1
XDS3		same as XDS1

NON-REFERENCED PARTS LIST

	60A86101	LENS, indicator: RED; for DS3
	60K86102	LENS, indicator: GREEN; for DS1
	60A14380	LENS, indicator: RED; for DS2
	28A474006	CONNECTOR, plug: male; single contact; round bakelite wafer insulator; cable mounted; for LZ or HZ Antenna Lead-In
	28A42310	CONNECTOR, plug: male; single contact; round molded mica filled phenolic insulator; cable mounted; for VHF Monitor Antenna Lead-In
	58K854020	ADAPTER, coaxial cable: reducer for use with 28A42310 Connector to fit RG-58A/U R-F Cable

FREQUENCY MEASUREMENT

CONTROL	POSITION
ON-OFF switch	ON
DB METER switch	LINE position
MON CHANNEL SEL switch	Channel being monitored
GAIN control	OFF (fully counterclockwise)
XTAL HEATER switch	OFF
CALIB switch	MOD TEST NORMAL position
METERING switch	Position 4
SELECTOR switch	0-20 KC. M.D. position

CARRIER FREQUENCY meter indicates if the monitored transmitter is "on" frequency. For critical carrier frequency setting, set SELECTOR switch in 0-10 KC. M.D. position and read the 3-0-3 KC. scale of the CARRIER FREQUENCY meter.

RELATIVE SIGNAL STRENGTH MEASUREMENT

DB METER switch	LINE position
MON CHANNEL SEL switch	Channel being monitored
WWV-AF GAIN control	OFF (fully counterclockwise)
XTAL HEATER Switch	OFF
CALIB switch	MOD TEST NORMAL position
METERING switch	Pos. 1, 2, or 3 (#3 being most sensitive)
SELECTOR switch	0-20 KC. M.D. position

Compare CARRIER FREQUENCY meter readings of two or more monitored transmitters.

FREQUENCY MODULATION DEVIATION MEASUREMENT

DB METER switch	MONITOR position
MON CHANNEL SEL switch	Channel being monitored
WWV-AF GAIN control	OFF-(fully counterclockwise)
XTAL HEATER switch	OFF
CALIB switch	MOD TEST NORMAL position
METERING switch	Position 4
SELECTOR switch	0-20 KC. M.D. position

MODULATION DEVIATION meter indicates frequency deviation directly in kilocycles. For systems having modulation deviation under 10 kc, set the SELECTOR switch in the 0-10 KC. M.D. position and read the amount of deviation on the 0-10 KC. scale of the MODULATION DEVIATION meter.

VOICE MODULATION MEASUREMENT

Set the controls the same as for the FREQUENCY MODULATION DEVIATION MEASUREMENT and modify the MODULATION DEVIATION meter readings as follows:

With voice modulation of a transmitter using INSTANTANEOUS DEVIATION CONTROL (IDC) or other good forms of compression and with the audio being limited, a 17.5 kc reading on the MODULATION DEVIATION meter indicates a peak deviation of 15 kc.

With voice modulation of a transmitter not incorporating IDC, a 7.5 kc reading indicates a 'peak' deviation of 15 kc.

MOTOROLA INC. Communications Division

ENGINEERING PUBLICATIONS 4501 WEST AUGUSTA BOULEVARD CHICAGO, ILLINOIS 60651

DETAILED MEASUREMENT INSTRUCTIONS

1. FREQUENCY MEASUREMENT

a. To monitor a transmitter for operation on the correct frequency, set the front panel controls as follows:

(1) ON-OFF switch - ON
(2) DB METER switch - LINE position
(3) WWV - AF GAIN control - OFF (fully COUNTERCLOCKWISE)
(4) METERING switch - Position 4
(5) XTAL HEATER switch - OFF
(6) CALIB switch - MOD TEST NORMAL position

b. Place the MON CHANNEL SEL switch to one of the first five positions corresponding to the channel being monitored.

(1) Place carrier to be monitored "on the air".

(2) Identify monitored carrier signal by listening to speaker output.

(3) CARRIER FREQUENCY meter indicates if the monitored transmitter is "on" frequency. For critical carrier frequency setting, set SELECTOR switch in 0-10 KC. M.D. position and read the 3-0-3 KC. scale of the CARRIER FREQUENCY meter.

(a) Zero meter deflection - indicates carrier "on" frequency.

(b) Left meter deflection - indicates carrier below frequency.

(c) Right meter deflection - indicates carrier above frequency.

2. RELATIVE SIGNAL STRENGTH MEASUREMENT

a. To make a comparison of transmitter signal strength set the front panel controls as follows:

(1) DB METER switch - LINE position
(2) WWV - AF GAIN control - OFF (fully COUNTERCLOCKWISE)
(3) METERING switch - Position 1, 2 or 3, depending upon sensitivity required (Pos. #3 being most sensitive).
(4) XTAL HEATER switch - OFF
(5) CALIB switch - MOD TEST NORMAL Position
(6) SELECTOR switch - 0-20 KC. M.D. position.

b. Place the MON CHANNEL SEL switch to one of the first five positions which corresponds to the channel being monitored.

NOTE

The following steps are based on the assumption that at least two transmitters operating on the same channel are being monitored.

c. Place transmitter No. 1 on the air and log the CARRIER FREQUENCY meter reading taken with the METERING switch in position 1, 2, or 3. Position 3 should give the highest reading.

d. Place transmitter No. 2 on the air and log the CARRIER FREQUENCY meter reading with the METERING switch in the same position as in step c.

e. Compare the two meter readings. The difference between them is an indication of the relative signal strength.

3. MODULATION DEVIATION MEASUREMENT

The MODULATION DEVIATION meter actually responds to average voltage; the meter scale, however, is calibrated in terms of peak voltage based on a sine wave signal. When the wave input departs from the pure sine wave the meter reading does not indicate the true energy level of the signal. This energy level can be expressed as the ratio of the average voltage to peak voltage of the incoming waveform. If this value is above the value of the sine wave, the meter reads high; if this value is below the sine wave value, the meter reads low.

To measure the modulation deviation set the front panel controls as follows:

(1) DB METER switch - MONITOR position.

(2) WWV - AF GAIN control - OFF (fully counterclockwise).

(3) METERING switch - Position 4.

(4) XTAL HEATER switch - OFF.

(5) CALIB switch - MOD TEST NORMAL position.

(6) Place the MON CHANNEL selector switch to the crystal position which corresponds to the channel being monitored.

(7) Place the SELECTOR switch on the 0-10 KC. M.D. position for modulation deviation under 10 kc., or on the 0-20 KC. M.D. position for modulation over 10 kc., and read the appropriate scale on the MODULATION DEVIATION meter.

4. MEASUREMENT METHODS

The methods which can be utilized to measure modulation deviation are described below. These methods, listed in order of degree of accuracy are as follows:

(1) Oscilloscope method.

(2) Modulation deviation meter method.

These methods, described in the following paragraph, are applicable to all types of channel spacing operation. However, for any other channel spacing, merely substitute the values given below for the ±15 kc deviation.

The values for modulation deviation for specific channel spacing operations are as follows:

(1) For 20 kc channel spacing, ±5 kc deviation.

(2) For 30 kc channel spacing, ±5 kc deviation.

(3) For 40 kc channel spacing, ±15 kc deviation.

(4) For 50 kc channel spacing, ±15 kc deviation.

(5) For 60 kc channel spacing, ±15 kc deviation.

(6) For 120 kc channel spacing, ±15 kc deviation.

5. MEASUREMENT PROCEDURE

a. Oscilloscope Method

The test equipment required is as follows:

(1) Oscilloscope - Motorola Model T1015A General Purpose Oscilloscope, or equivalent.

(2) 1000 cps tone generator - Motorola Model TEK-1A Transistorized Tone Oscillator, or equivalent.

(3) High impedance a-c voltmeter - Motorola Transistorized AC Voltmeter, or equivalent.

Connect the oscilloscope to the two binding posts on the front panel of the FM station monitor. Connect the 1000 cps tone generator and a-c voltmeter across the microphone input terminals on the transmitter.

The oscilloscope must be calibrated before accurate measurements can be made.

Calibrate the oscilloscope as follows:

In a ±15 kc deviation system modulate the transmitter with a 1000 cycle tone set at a level which produces a ±7 kc deviation on the monitor deviation meter. Set the vertical gain on the oscilloscope to any convenient height, e.g., 7 squares on the oscilloscope face. This calibrates the oscilloscope for a reading of 1 square for each kc deviation. The calibrated oscilloscope is now an accurate deviation indicator.

Proceed as follows:

(1) Turn the IDC control on the transmitter to the fully open position (clockwise).

(2) Apply the 1000 cycle tone signal to the transmitter.

(3) Increase the signal to a minimum of one volt (measured across the audio input terminals on the transmitter).

(4) Turn the IDC control slowly in the counterclockwise direction until a reading of ±15 kc is observed on the oscilloscope.

The above procedure provides an accurate level setting of the transmitter IDC control circuit. The oscilloscope is a highly reliable deviation indicator since it is instantaneous in action and the peak reading is unaffected by the waveform. It is important that the operational line voltage be kept constant as any change in line voltage will affect the calibration.

NOTE

When monitoring transmitters which operate in the 450-470 mc band, the oscilloscope reading must be one-third of ±15 kc or ±5 kc. This is due to the fact that the frequency being monitored is actually that which precedes the final tripler stage of the transmitter.

b. Modulation Deviation Meter Method

NOTE

The MODULATION DEVIATION meter responds correctly to sinusoidal waves only. Transmitters having Instantaneous Deviation Control (IDC) adjustments produce a wave containing a large number of harmonics, which will present erroneous readings on the MODULATION DEVIATION meter. An oscilloscope calibrated with the MODULATION DEVIATION meter is the most accurate device for transmitter deviation settings. A secondary, less reliable, method is described below.

(1) Connect a 1000 cycle tone generator and a high impedance a-c voltmeter across the microphone input terminals on the transmitter.

(2) Adjust the input signal to a minimum of one volt (measured across the microphone input terminals on the transmitter).

(3) Using the MODULATION DEVIATION meter, set the amount of deviation, by adjusting the IDC control on the transmitter, to ±15 kc. for a 15 kc. system, unless otherwise stated in the manual.

NOTE

When monitoring transmitters which operate in the 450-470 mc band, the reading must be multiplied by three to obtain the actual deviation. The IDC control should be adjusted for an approximate 5 kc reading on the MODULATION DEVIATION METER.

6. CRYSTAL DATA

Although the Motorola Frequency Monitor is designed to monitor only five channels in any one frequency band, more channels may be monitored by a simple exchange of channel crystals.

When ordering SFMT-2 crystals for additional channel monitoring, be sure to specify the following information:

1. List of new channels to be monitored.

2. List all of the channels presently being monitored.

3. Frequency at which the Control Receiver is aligned. (150, 155, 160, or 170 mc.)

4. Crystal type and frequency of each and every crystal used in the FM Station Monitor.

Under some conditions, the addition of certain SFMT-2 crystals may necessitate realignment of the Control Receiver to a new control frequency, and the replacement of some, or conceivably all, of the existing crystals in the monitor, in order to reduce the possible development of interference to the control receiver due to the high order harmonics from the SFMT-2 crystals.

Refer to the Calibration Label, Motorola Part No. 54B863821, attached to each FM station Monitor, as a guide for the above information. If desired, one part of the calibration Label may be detached, properly filled in, and mailed to the factory to facilitate the ordering of crystals.

NOTE

The transmitter that is to be monitored should be turned off and all extraneous signals should be eliminated when aligning the control receiver.

Monitoring of FM stations within the 162-174 mc range may be accomplished with the use of proper channel crystals (or using the TRD-1090-A receiver in place of the TRD1080A receiver.) These crystals are selected in the same manner as those in the 152-162 mc range. When monitoring stations within the 167.5-174 mc range the control receiver (TRD1080A) should be aligned to 160 mc. Since the upper frequency limit of the channel crystals is approximately 12 mc, the channel crystal 2nd harmonic must be used when monitoring stations within the 172-174 mc range.

NOTE

For further channel crystal frequency information, contact your local Motorola representative.

To Monitor Freq (MC)	Control Rec. and SFMT-2 Freq. 150	155	160	170	To Monitor Freq (MC)	Control Rec. and SFMT-2 Freq. 150	155	160	170	To Monitor Freq (MC)	Control Rec. and SFMT-2 Freq. 150	155	160	170
150.80		4200	9200		152.63		2370	7370		154.340	4340		5660	
150.83		4170	9170		152.69		2310	7310		154.355	4355		5645	
150.86		4140	9140		152.75	2750		7250		154.370	4370		5630	
150.89		4110	9110		152.81	2810		7190		154.385	4385		5615	
150.92			9080		152.87	2870	2130	7130		154.400			5600	
150.95			9050		152.90	2900	2100			154.415			5585	
150.98			9020		152.93	2930	2070	7070		154.430	4430		5570	
151.01			8990		152.96	2960		7040		154.460	4460		5555	
151.04			8960		152.99	2990		7010		154.475	4475		5525	
151.07			8930		153.02	3020		7040		154.490	4490		5510	
151.10		3900	8900		153.05	3050	1950	6950		154.540	4540		5460	
151.13		3870	8870		153.08	3080	1920	6920		154 570	4570		5430	
151.16		3840	8840		153.11	3110		6890		154.600	4600		5400	
151.19		3810	8810		153.14	3140	1860			154.650	4650		5350	
151.22		3780	8780		153.17	3170		6830		154.665	4665			
151.25		3750	8750		153.20	3200	1800	6800		154.680	4680		5320	
151.28		3720	8720		153.23	3230		6770		154.695	4695		5303	
151.31			8690		153.26			6740		154.710	4710			
151.34			8660		153.29	3290		6710		154.725	4725		5275	
151.37		3630	8630		153.32	3320	1680	6680		154.740	4740		5260	
151.40		3600	8600		153.35	3350		6650		154.755	4755		5245	
151.43		3570	8570		153.38	3380		6620		154.770	4770			
151.46		3540	8540		153.41			6590		154.785			5215	
151.49		3510	8510		153.44	3440		6560		154.800			5200	
151.52		3480	8480		153.47	3470		6530		154.815	4815		5185	
151.55		3450	8450		153.50	3500		6500		154.830	4830		5170	
151.58		3420			153.53	3530		6470		154.860	4860		5140	
151.61			8390		153.56	3560		6440		154.875	4875		5125	
151.64	1640	3360	8360		153.59	3590		6410		154.890	4890		5110	
151.67	1670	3330	8330		153.62	3620		6380		154.905	4905		5095	
151.70	1700		8300		153.65	3650		6350		154.920	4920		5080	
151.73	1730	3270	8270		153.68			6320		154.935	4935		5065	
151.76	1760	3240	8240		153.71	3710				154.950	4950		5050	
151.79	1790	3210	8210		153.755	3755		6245		154.965			5035	
151.82	1820	3180	8180		153.77	3770		6230		154.980	4980		5020	
151.85		3150	8150		153.785	3785		6215		154.995	4995		5005	
151.88	1880	3120			153.83	3830				155.01	5010		4990	
151.91	1910				153.89	3890		6110		155.025	5025		4975	
151.94	1940	3060			153.95			6050		155.040	5040		4960	
151.97		3030			154.01			5990		155.055	5055		4945	
152.00		3000			154.07			5930		155.070	5070		4930	
152.03		2970			154.13	4130		5870		155.085	5055		4915	
152.09	2090	2910			154.16	4160		5840		155.100	5100		4900	
152.15	2150	2850			154.175	4175		5825		155.115	5115		4885	
152.21	2210	2790	7790		154.190	4190		5810		155.130	5130		4870	
152.27	2270	2730	7730		154.205	4205		5795		155.145	5145		4855	
152.30			7700		154.220	4220		5780		155.160	5160		4840	
152.33	2330		7670		154.235	4235				155.175	5175		4825	
152.36	2360		7640		154.25	4250		5750		155.190	5190		4810	
152.39	2390	2610	7610		154.265	4265		5735		155.205	5205		4795	
152.42		2580			154.280	4280		5720		155.220	5220		4780	
152.45	2450	2550	7550		154.295	4295		5705		155.235	5235		4765	
152.51	2510	2490	X		154.310	4310		5690		155.250	5250		4750	
152.57	2570	2430	7430		154.325			5675						

To Monitor Freq (MC)	Control Rec. and SFMT-2 Freq. 150	155	160	170	To Monitor Freq (MC)	Control Rec. and SFMT-2 Freq. 150	155	160	170	To Monitor Freq (MC)	Control Rec. and SFMT-2 Freq. 150	155	160	170
155.265	5265		4735		155.850	5850		4150		156.465	6465		3535	
155.280	5280		4720		155.865	5865		4135		156.480	6480		3520	
155.295	5295		4705		155.880	5880		4120		156.495	6495		3505	
155.310	5310		4690		155.895	5895				156.510	6510		3490	
155.325	5325		4675		155.910	5910		4090		156.525			3475	
155.340	5340		4660		155.925	5925		4075		156.540	6540		3460	
*155.355					155.940	5940				156.555	6555		3445	
155.370	5370		4630		155.955	5955				156.570	6570		3430	
155.385	5385		4615		155.970	5970				156.585	6585		3415	
155.400	5400		4600		155.985	5985				156.615	6615	1615	3385	
155.415	5415		4585		156.000	6000				156.630	6630		3370	
155.430	5430		4570		156.015	6015				156.645	6645	1645	3355	
155.445	5445		4555		156.030	6030				156.660	6660	1660	3340	
155.460	5460		4540		156.045	6045				156.675	6675		3325	
155.475	5475		4525		156.060	6060				156.690	6690		3310	
155.490	5490		4510		156.075	6075		3925		156.705		1705	3295	
155.505	5505		4495		156.090	6090		3910		156.720	6720	1720	3280	
155.520			4480		156.105	6105				156.735	6735	1735		
155.535	5535		4465		156.120	6120		3880		156.750	6750	1750	3250	
155.550	5550		4450		156.135	6135		3865		156.765	6765	1765	3235	
155.565	5565		4435		156.150	6150		3850		156.780	6780		3220	
155.580	5580		4420		156.165	6165		3835		156.795	6795	1795	3205	
155.595	5595		4405		156.180	6180		3820		156.810	6810	1810	3190	
155.610	5610		4390		156.195	6195		3805		156.825	6825		3175	
155.625	5625		4375		156.210	6210		3790		156.840	6840	1840	3160	
155.640	5640				156.225	6225		3775		156.855	6855		3145	
155.655	5655		4345		156.240	6240		3760		156.870	6870	1870	3130	
155.670	5670		4330		156.270	6270		3730		156.885	6885	1885	3115	
155.685	5685		4315		156.285	6285		3715		156.900		1900	3100	
155.700	5700		4300		156.300	6300				156.915	6915		3085	
155.715	5715		4285		156.315	6315		3685		156.930	6930		3070	
155.730	5730		4270		156.330	6330		3670		156.945	6945	1945	3055	
155.745	5745		4255		156.345	6345		3655		156.960	6960	1960	3040	
155.760	5760		4240		156.360	6360		3640		156.975	6975		3025	
155.775	5775		4225		156.390	6390		3610		156.990	6990		3010	
155.790	5790				156.405	6405		3595		157.005	7005		2995	
155.805	5805		4195		156.420	6420		3580		156.020	7020		2980	
155.820	5820		4180		156.435	6435		3565		157.035	7035			
155.835	5835		4165		156.450	6450		3550		157.050	7050	2050	2950	

*Use 152.5 Rec SFMT-2 4.200

To Monitor Freq (MC)	Control Rec. and SFMT-2 Freq.				To Monitor Freq (MC)	Control Rec. and SFMT-2 Freq.				To Monitor Freq (MC)	Control Rec. and SFMT-2 Freq.			
	150	155	160	170		150	155	160	170		150	155	160	170
157.065	7065		2935		157.815	7815	2815	2185		158.655	8655			11345
157.080	7080	2080	2920		157.830	7830	2830	2170		158.670	8670			
157.095	7095		2905		157.845	7845	2845	2155		158.730	8730	3730		
157.110	7110	2110	2890		157.860			2140		158.745	8745	3745		11255
157.125	7125		2875		157.875		2875	2125		158.760	8760			11240
157.140			2860		157.890		2890	2110		158.775	8775			11225
157.155	7155	2155	2845		157.905		2905	2095		158.790	8790			
157.170	7170	2170	2830		157.920		2920	2080		158.805	8805	3805		11195
157.185	7185		2815		157.935		2935	2065		158.820		3820		11180
157.200	7200				157.950		2950			158.835	8835	3835		11165
157.215	7215		2785		157.965		2965			158.850	8850	3850		
157.230	7230	2230	2770		157.995		2995		12005	158.865	8865			11135
157.245	7245		2755		158.010		3010			158.880	8880	3880		11120
157.260	7260	2260	2740		158.025		3025		11975	158.895	8895	3895		11105
157.275	7275	2275			158.040			1960	11960	158.910	8910	3910		
157.290	7290	2290			158.055		3055	1945	11945	158.925				11075
157.305	7305	2305			158.070		3070	1930		158.940				11060
157.320	7320	2320	2680		158.130			1870		158.955	8955			11045
157.335	7335	2335			158.160	8160				158.970	8970			
157.350	7350	2350			158.190	8190	3190	1810		158.985	8985			11015
157.365	7365	2365	2635		158.220	8220	3220	1780	11780	159.000	9000			
157.380	7380	2380			158.250		3250	1750		159.015	9015			10985
157.395	7395		2605		158.280	8280	3280	1720	11720	159.030	9030			
157.410	7410	2410	2590		158.310	8310		1690		159.045	9045			10955
157.425	7425	2425	2575		158.340		3340	1660	11660	159.060	9060			10940
157.440			2560		158.370	8370				159.075	9075	4075		10925
157.455	7455	2455	2545		158.400	8400	3400		11600	159.090	9090	4090		
157.470	7470	2470	2530		158.430	8430	3430			159.105	9105	4105		10895
157.485	7485	2485	2515		158.490	8490				159.120	9120	4120		10880
157.530	7530	2530	2470		158.505	8505	3505		11495	159.135	9135	4135		10865
157.560	7560	2560			158.520	8520			11480	159.150	9150	4150		
157.590	7590	2590	2410		158.535	8535	3535		11465	159.165	9165	4165		10835
157.620	7620		2380		158.550	8550	3550			159.180	9180	4180		10820
157.650	7650		2350		158.565	8565			11435	159.195	9195	4195		10805
157.680	7680				158.580	8580	3580		11420	159.210	9210	4210		
157.710	7710		2290		158.595	8595	3595		11405	159.225	9225	4225		10775
157.770	7770		2230		158.610	8610	3610			159.240	9240	4240		10760
157.785	7785	2785			158.625		3625		11375	159.255	9255	4255		10745
157.800	7800	2800	2200		158.640	8640	3640		11360	159.270	9270	4270		

To Monitor Freq (MC)	Control Rec. and SFMT-2 Freq.				To Monitor Freq (MC)	Control Rec. and SFMT-2 Freq.				To Monitor Freq (MC)	Control Rec. and SFMT-2 Freq.			
	150	155	160	170		150	155	160	170		150	155	160	170
159.285	9285	4285		10715	159.900	9900	4900		10100	160.500	10500			
159.300	9300	4300		10700	159.915	9915	4915		10085	160.515	10515	5515		9485
159.315	9315	4315		10685	159.930	9930	4930		10070	160.530	10530	5530		9470
159.330	9330				159.945	9945	4945		10055	160.545	10545	5545		9455
159.345	9345			10655	159.960	9960			10040	160.575	10575	5575		9425
159.360	9360	4360		10640	159.975	9975			10025	160.590	10590	5590		9410
159.375	9375				159.990		4990		10010	160.605	10605	5605		9395
159.390	9390	4390			160.005		5005			160.620	10620	5620		9380
159.405	9405	4405		10595	160.020		5020		9980	160.635	10635	5635		9365
159.420	9420	4420		10580	160.035	10035	5035		9965	160.650	10650	5650		9350
159.435	9435			10565	160.050	10050	5050		9950	160.665	10665	5665		9335
159.450	9450	4450			160.065	10065	5065		9935	160.680	10680	5680		9320
159.465	9465	4465		10535	160.080	10080	5080		9920	160.695	10695	5695		9305
159.480	9480			10520	160.095	10095	5095		9905	160.710		5710		9290
159.495	9495	4495		10505	160.110	10110			9890	160.725	10725	5725		9275
159.510	9510	4510		10490	160.125	10125	5125			160.740	10740			9260
159.525	9525	4525		10475	160.140	10140	5140		9860	160.755	10755	5755		9245
159.540	9540	4540		10460	160.155	10155	5155		9845	160.770	10770	5770		9230
159.555				10445	160.170	10170	5170		9830	160.785	10785	5785		9215
159.570	9570	4570		10430	160.185	10185	5185		9815	160.800	10800	5800		
159.585	9585	4585		10415	160.200				9800	160.815		5815		9185
159.600		4600		10400	160.215	10215	5215		9785	160.830	10830	5830		9170
159.615	9615	4615		10385	160.230	10230	5230		9770	160.845	10845	5845		9155
159.630	9630	4630		10370	160.245	10245	5245		9755	160.860	10860	5860		9140
159.645	9645	4645		10355	160.260	10260	5260		9740	160.875	10875	5875		9125
159.660	9660	4660		10340	160.275	10275	5275		9725	160.890	10890	5890		9110
159.675	9675	4675		10325	160.290	10290	5290		9710	160.905	10905	5905		9095
159.690	9690	4690		10310	160.305		5305		9695	160.920	10920	5920		9080
159.705	9705	4705		10295	160.320	10320	5320		9680	160.935	10935	5935		
159.720	9720	4720		10280	160.335	10335	5335		9665	160.950	10950	5950		9050
159.735	9735	4735			160.350	10350	5350		9650	160.965	10965			9035
159.750	9750	4750		10250	160.365	10365	5365		9635	160.980	10980	5980		9020
159.765	9765	4765		10235	160.380	10380	5380			160.995	10995	5995		9005
159.780	9780	4780		10220	160.395	10395	5395		9605	161.010	11010	6010		8990
159.795	9795			10205	160.410	10410	5410		9590	161.025	11025	6025		
159.810	9810	4810		10190	160.425	10425	5425		9575	161.040				8960
159.825	9825	4825		10175	160.440	10440	5440		9560	161.055	11055	6055		
159.840	9840			10160	160.455	10455	5455		9545	161.070	11070	6070		8930
159.855	9855	4855		10145	160.470	10470	5470		9530	161.085	11085			8915
159.870	9870	4870		10130	160.485	10485	5485		9515	161.100	11100	6100		8900
159.885	9885	4885		10115										

To Monitor Freq (MC)	Control Rec. and SFMT-2 Freq.				To Monitor Freq (MC)	Control Rec. and SFMT-2 Freq.				To Monitor Freq (MC)	Control Rec. and SFMT-2 Freq.			
	150	155	160	170		150	155	160	170		150	155	160	170
161.115	11115	6115		8885	161.445	11445	6445			161.775	11775	6775		8225
161.130	11130	6130		8870	161.460	11460			8540	161.790	11790	6790	1790	8210
161.145	11145	7145		8855	161.475	11475	6475		8525	161.805	11805	6805	1805	8195
161.160		6160		8840	161.490		6490		8510	161.820	11820	6820	1820	8180
161.175		6175		8825	161.505	11505	6505			161.835	11835	6835	1835	8165
161.190	11190	6190		8810	161.520	11520	6520		8480	161.850	11850	6850	1850	8150
161.205	11205			8795	161.535		6535		8465	161.910	11910	6910	1910	8090
161.220	11220	6220		8780	161.550	11550	6550		8450	161.925	11925	6925	1925	8075
161.235	11235	6235		8765	161.565	11565	6565		8435	161.940	11940	6940	1940	8060
161.250	11250	6250		8750	161.580	11580	6580		8420	161.955	11955		1955	8045
161.265	11265	6265		8735	161.595	11595	6595		8405	161.970	11970	6970		
161.280	11280			8720	161.610	11610	6610		8390	161.985	11985	6985		8015
161.295	11295	6295		8705	161.625	11625			8375	162.000		7000		8000
161.310	11310	6310		8690	161.640	11640	6640	1640	8360	173.225	6612.5	9112.5		3225
161.325	11325	6325		8675	161.655	11655	6655		8345	173.250	6625		6625	
161.340	11340	6340		8660	161.670	11670	6670		8330	173.275			6637.5	
161.355	11355	6355		8645	161.685	11685	6685		8315	173.300	6650	9150	6650	3300
161.370	11370	6370		8630	161.700	11700	6700			173.325	6662.5	9162.5		3325
161.385	11385	6385		8615	161.715	11715	6715		8285	173.350	6675	9175	6675	
161.400	11400	6400			161.730	11730	6730	1730	8270	173.375	6687.5	9187.5	6687.5	3375
161.415	11415	6415		8585	161.745	11745		1745	8255					
161.430	11430	6430		8570	161.760	11760	6760	1760	8240					

CALIBRATION INSTRUCTIONS

To meet FCC requirements, it is necessary to calibrate the Frequency Monitor at least once every six months.

1. CRYSTAL CALIBRATION

a. Set the front panel controls as follows:

(1) ON-OFF switch -- ON
(2) XTAL HEATER switch -- OFF
(3) WWV-AF GAIN control -- OFF (fully counterclockwise)
(4) MON CHANNEL SEL switch -- In one of the first five positions
(5) DB METER switch -- LINE position
(6) CALIB switch -- WWV REC position

Allow the equipment to warm up for at least one hour with the controls positioned as indicated above.

b. Rotate the WWV-AF GAIN control clockwise to turn on the WWV receiver. Adjust the audio for the desired level.

NOTE

Do not keep the WWV receiver on for long periods of time. It should be turned on for calibration purposes only.

c. Set the WWV SEL switch to position A or B and tune in the signal from Radio Station WWV by using the WWV TUNE control. Use the WWV SEL switch position which provides the best reception.

NOTE

Care must be exercised to ascertain that a beat note is not tuned in with the WWV signal as this would result in an incorrect zero beat.

d. Place the MON CHANNEL SEL switch in the DISC CALIB position.

e. Zero beat the calibration crystal output against the WWV signal as outlined in the following steps. This procedure, if followed in detail, will insure correct zero beating and calibration.

(1) When the WWV carrier is unmodulated, vary the STD XTAL ADJ control until the beat note between the crystal and the unmodulated carrier is unaudible. An alignment tool for this purpose is supplied with the equipment.

NOTE

Radio Station WWV removes modulation every five minutes.

(2) When the carrier is again tone modulated, vary the STD XTAL ADJ control (turn slowly and for a very small distance) until the audio amplitude variations of the WWV modulations are reduced to one per second or less. Turn the control slightly clockwise to compenstate for the capacity effect of the tuning tool. The audio amplitude variations should not be greater than two or three per second with the tuning tool removed. This is the correct zero beat.

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2. CARRIER FREQUENCY METER ZERO SET

a. Turn the WWV-AF GAIN control to the complete COUNTERCLOCKWISE position. The rectangular RED indicator light will go out, indicating that the WWV receiver is "off".

b. Set the front panel controls as follows:

(1) METERING switch in position 4.

(2) CALIB switch in MOD TEST NORMAL position.

(3) DB METER switch in LINE position

(4) MON CHANNEL SEL switch in DISC CALIB position

(5) SELECTOR switch in 0-20 KC. M.D. position.

c. The GREEN indicator lamp will light, indicating that the calibration crystal is feeding a signal into the control receiver.

d. Observe the CARRIER FREQUENCY Meter reading and adjust the zero set control until the meter reading is zero.

e. Set the SELECTOR switch to the 0-10 KC. M.D. position.

f. Adjust the "Zero Adjust" control on the Bracket Assembly, located behind the front panel, until the CARRIER FREQUENCY Meter reading is zero.

NOTE

An off-zero reading with no carrier signal present or with the MON CHANNEL SEL switch in any of the first five positions is not an indication of off-calibration and has no effect on the meter reading obtained with the MON CHANNEL SEL switch in the disc calib position.

3. AUDIO GAIN CALIBRATION

The setting of the volume control on the control receiver has a direct effect on the readings obtained on the MODULATION DEVIATION meter. To calibrate the gain of the control receiver audio amplifier in terms of frequency deviation, i.e., to obtain correct MODULATION DEVIATION meter readings, set the control receiver volume control as outlined in the following steps.

a. Set the front panel controls as follows:

(1) WWV-TUNE control is not Affected

(2) WWV-SEL switch is not Affected

(3) METERING switch in position 4 (discriminator)

(4) Turn the WWV-AF GAIN control 1/4 turn clockwise from "OFF".

(5) CALIB switch in the CALIB MOD position.

(6) DB METER switch in the MONITOR position.

(7) MON CHANNEL SEL switch in the DISC CALIB position

(8) XTAL HEATER switch is OFF

(9) SELECTOR switch in the 0-10 kc M.D. position.

Note: Oscilloscope not used in this calibration.

b. Allow the equipment to warm up a few minutes until the MODULATION DEVIATION Meter stops drifting. Adjust the WWV-AF GAIN control until the MODULATION DEVIATION Meter reads the value indicated under "1. CALIB. MOD. position" on the frequency calibration tag attached to the monitor.

c. Turn the CALIB SW. to "MOD TEST NORMAL" position and adjust the volume control on the Control Receiver to obtain a reading on the MODULATION DEVIATION meter, exactly equal to the one appearing on the Calibration Label "MOD TEST NORMAL" section attached to each FM Station Monitor.

d. Turn the SELECTOR switch to the 0-20 KC. M.D. position and adjust the MODULATION DEVIATION control, located on the Bracket Assembly, to obtain the proper reading on the 0-20 Kc scale of the MODULATION DEVIATION meter.

e. Repeat steps b, c, and d, to insure proper calibration.

This calibrates and sets the audio gain of the control receiver so that correct readings are indicated on the MODULATION DEVIATION meter. If the gain of the audio amplifier of the control receiver is changed by moving the volume control, by changing tubes, or by other means the amplifier must be recalibrated as outlined.

4. DISCRIMINATOR SLOPE

The discriminator slope (frequency displacement versus output voltage) of the control receiver should be checked periodically for proper operation. This should be done only when the signal from WWV is strong enough to produce a good beat note between WWV and the calibration crystal. The discriminator slope is checked as follows:

a. Repeat the Crystal Calibration Procedure, paragraph 1 of this section.

b. With the "Selector" switch in the "0-20 KC. M.D. position", adjust the zero set control until the CARRIER FREQUENCY meter reads zero.

c. When the WWV carrier is modulated, vary the STD XTAL ADJ control until the tone of the beat note between the calibration crystal and WWV is the same as the tone of the WWV modulation. The two audio notes should now be of the same frequency. This may be checked by momentarily turning the CHANNEL SEL switch off the DISC CALIB position. This action should not produce any difference in the tone of the audio beat note.

NOTE

The STD XTAL ADJ control may not be able to vary the crystal frequency sufficiently to produce a beat note equal to the WWV modulation frequency. In this case, adjust the audio beat note to 1/2 of the WWV audio frequency. Thus, the second harmonic of this beat note will be equal to the WWV modulation frequency.

d. Observe the meter reading on the CARRIER FREQUENCY meter and log this value in the Field Meter Reading column of the Discriminator Slope Calibration Chart. If these readings do not coincide with the calculated readings, proper interpolation must be applied when frequencies are being monitored.

5. DISCRIMINATOR SLOPE CALIBRATION

The Discriminator Slope Calibration Chart contains check points for any of the four control receiver frequencies. Check points are calculated as outlined in the following example.

Assume that the WWV receiver is tuned to 10 mc, the control receiver is operating at 150 mc, the WWV modulation is 440 cycles, and using a 5 mc calibration crystal.

In order to produce a 440 cycle beat note between the 5 mc. crystal and the 10 mc WWV signal, the crystal frequency must be varied 220 cycles. If the crystal frequency is changed 220 cycles at 5 mc, it will be changed 440 cycles at its second harmonic of 10 mc. If the crystal is changed 220 cycles at its fundamental frequency, it will be changed 6.6 kc at its 30th harmonic of 150 mc. Thus, the frequency fed to the control receiver will be 150 mc ±6.6 kc and the CARRIER FREQUENCY meter should read ±6.6 kc with the METERING switch in position 4. This value is entered in the Calculated Meter Reading column of the Discriminator Slope Calibration Chart (see paragraph 9).

6. HIGH RECOVERY DISCRIMINATOR CALIBRATION

To adjust the High Recovery Discriminator, set the MON CHANNEL SEL switch to any unused channel, and connect a jumper between pins 4 and 5 of the discriminator. Using the TU546 Test Set, or a highly accurate signal source, connect the output signal of 457 kc, through a 50 uuf capacitor, to pin 1 of V-7. Connect a Motorola DC Multimeter, or equivalent from pins 4 and 5 to ground, and tune the primary (bottom tuning slug) for a maximum meter reading. Remove the jumper, and adjust the secondary (top tuning slug) for a zero reading on the CARRIER FREQUENCY meter, 3-0-3 kc. scale, with the SELECTOR switch on the 0-10 KC M.D. position. Set the output of the signal source to 456 kc, and adjust the Slope Adjust Control for a 1 kc reading to the right, on the CARRIER FREQUENCY meter (3-0-3 KC. scale). Set the output of the signal source to 459 kc, and adjust the Slope Adjust Control for a 2 kc meter reading to the left, on the CARRIER FREQUENCY meter (3-0-3 KC. scale). Repeat the above adjustments on the discriminator secondary, and the Slope Adjust Control until all readings are satisfactory.

7. OSCILLOSCOPE CALIBRATION

a. Connect the oscilloscope to the binding posts on the front panel.

b. Follow steps a, b, c and d of the Audio Gain Calibration procedure.

c. In a ±15 kc deviation system, modulate the transmitter (or FM signal generator, if available) with a 1000 cycle tone at a level which produces a ±7 kc deviation on the MODULATION DEVIATION Meter. A pure sine wave should be

produced on the oscilloscope. Set the vertical gain of the oscilloscope to any convenient height, e.g., 7 squares. In this way the oscilloscope is an accurate deviation indicator, regardless of wave shape.

NOTE

When checking instantaneous modulation deviation on a ±15 kc transmitter and the wave form on the oscilloscope expands beyond the calibrated value (i.e., more than 15 squares for 1 square per 1 kc calibration) the monitored transmitter is being over-modulated.

8. SERVICES OF THE NATIONAL BUREAU OF STANDARDS STATION WWV

The National Bureau of Standards maintains a service of technical radio broadcasts over station WWV at Beltsville, Maryland.

The services from WWV include:

a. Standard radio frequencies of 2.5, 5, 10, 15, 20, 25, 30 and 35 mc.

b. Radio propagation disturbance warnings by International Morse Code consisting of the letters W, U or N; indicating warning, unstable conditions, or normal conditions, respectively.

c. Time announcements at 5 minute intervals by voice and International Morse Code.

d. Standard audio frequencies of 440 and 600 cycles.

The audio frequencies are interrupted at precisely one minute before the hour and each five minutes thereafter, and are resumed precisely on the hour and each five minutes thereafter. Code announcements are in Greenwich Civil Time using a 24 hour system beginning with 0000 at midnight. Voice announcements are in Eastern Standard Time. The audio frequencies are transmitted alternately; the 600 cycle tone, continuing for four minutes, starts precisely on the hour and every ten minutes thereafter. Each carrier frequency is modulated by a seconds pulse which is heard as a faint tick; the pulse at the beginning of the last second of each minute is omitted.

The accuracy of all frequencies, radio and audio, is better than one part in fifty million. The time intervals marked by the pulse every second is accurate to 1 microsecond. The beginnings of the periods in which audio frequency transmissions are resumed are synchronized with the basic time service of the U.S. Naval Observatory.

The services of WWV are subject to change without notice.

9. RECEPTION OF STATION WWV

Reliable reception of station WWV should, in general, be possible at all times on one or the other of the two frequencies provided. Exceptions will occur during periods of radio propagation disturbances such as ionospheric storms. Selection of the frequency that gives best reception may be made by switching between the two and using the one most suitable. Bear in mind that the lower frequency will usually be better at night and the higher frequency will usually be better in the afternoon or late morning.

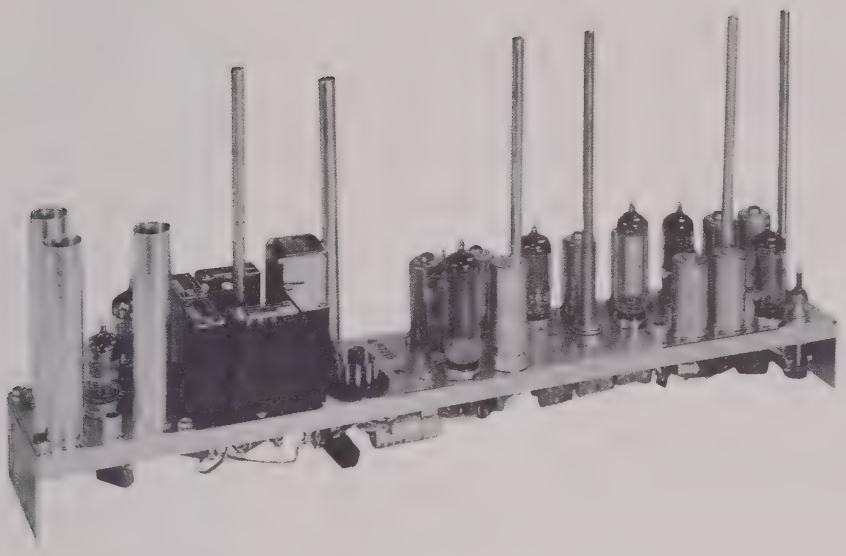
Should it be desired to predict in advance which of the frequencies will be most suitable, use may be made of the National Bureau of Standards, Central Radio Propagation Laboratory prediction service. The CRPL-D series of publications "Basic Radio Propagation Predictions", issued monthly three months in advance, plus Circular 465, NBS, "Instructions for the Use of Basic Radio Propagation Predictions" contains the required information. These publications may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C.

MOTOROLA DISCRIMINATOR SLOPE CALIBRATION CHART

W. W. V. Receiver Frequency	Control Receiver Frequency	Calculated Meter Reading 440∿Beat Note	Field Meter Reading	Calculated Meter Reading 220∿Beat Note	Field Meter Reading	Calculated Meter Reading 600∿Beat Note	Field Meter Reading	Calculated Meter Reading 300∿Beat Note	Field Meter Reading
5 mc	150 mc	*13.2 kc		*6.6 kc		Off Scale		*9 kc	
5 mc	155 mc	*13.64 kc		*6.82 kc		Off Scale		*9.3 kc	
5 mc	160 mc	*14.08 kc		*7.04 kc		Off Scale		*9.6 kc	
5 mc	170 mc	*14.96 kc		*7.48 kc		Off Scale		*10.2 kc	
10 mc	150 mc	*6.6 kc		3.3 kc		*9 kc		4.5 kc	
10 mc	155 mc	*6.82 kc		3.41 kc		*9.3 kc		4.65 kc	
10 mc	160 mc	*7.04 kc		3.52 kc		*9.6 kc		4.8 kc	
10 mc	170 mc	*7.48 kc		3.74 kc		*10.2 kc		5.1 kc	
15 mc	150 mc	4.4 kc		2.2 kc		6 kc		3 kc	
15 mc	155 mc	4.55 kc		2.27 kc		6.2 kc		3.1 kc	
15 mc	160 mc	4.7 kc		2.35 kc		6.4 kc		3.2 kc	
15 mc	170 mc	4.99 kc		2.49 kc		6.8 kc		3.4 kc	

*Values are not readable with most monitors because the trimmer capacitor (STD ADJ control) will not vary the crystal frequency over a sufficient range at these frequencies to produce a suitable beat note.

WWV RECEIVER & CALIBRATING OSCILLATOR



WWV RECEIVER

1. DESCRIPTION

a. General

The TRD1060A or TRD1070A Series WWV Receiver and Calibrating Oscillator consists of a special design am receiver and a crystal controlled and temperature compensated oscillator assembled in a strip design chassis. Two antenna connectors are provided on the WWV Receiver for connection of a low impedance or a high impedance antenna used for the reception of signals from Radio Station WWV. A vhf antenna connector is provided to supply signals from the transmitter being monitored to the calibrating oscillator section.

b. TRD1060A Chassis

The TRD1060A Receiver and Calibrating oscillator consists of the following units:

(1)	P-7215-A	Basic Chassis
(1)	P-7217	RF Deck
(1)	K-7214	Coil Kit (10-15 mc)

c. TRD1070A Chassis

The TRD1070A Receiver and Calibrating oscillator consists of the following units:

(1)	P-7215-A	Basic Chassis
(1)	P-7217	RF Deck
(1)	K-7214-A	Coil Kit (5-10 mc)

2. WWV RECEIVER ALIGNMENT

a. Equipment Required

(1) Model 80 Signal Generator, or equivalent, covering a frequency range of 1 to 20 mc, modulated with 400 cycles of audio.

(2) Alignment Tool which is supplied with the equipment.

b. Alignment Procedure

A complete alignment procedure, in chart form, for the WWV Receiver, and Calibrating Oscillator is included in this section.

MOTOROLA INC. COMMUNICATIONS DIVISION
Engineering Publications 4501 W. Augusta Blvd. Chicago 51, Illinois

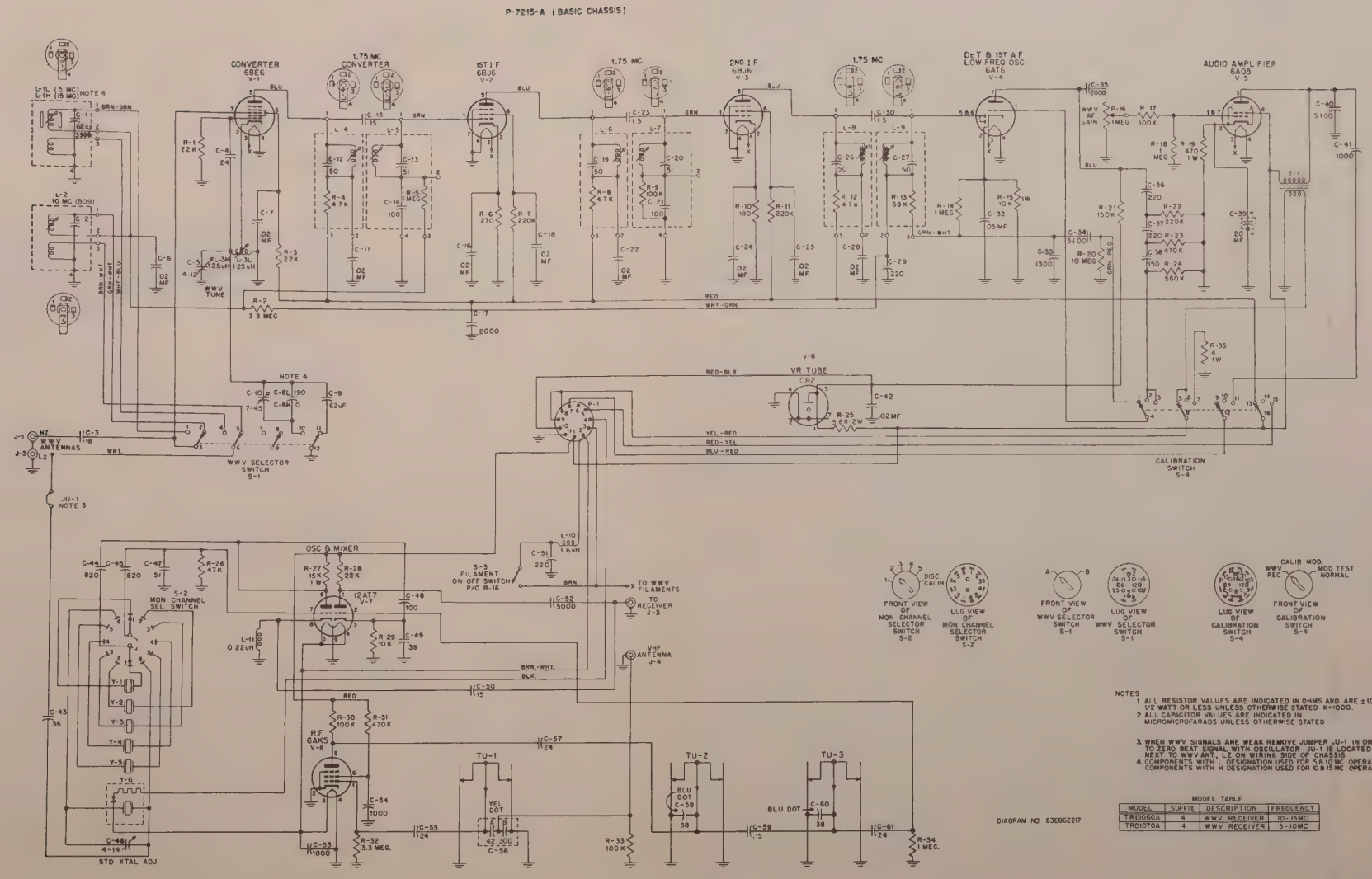
NOMINAL PERFORMANCE SPECIFICATIONS

BASIC UNIT	TRD1060A	TRD1070A
FREQUENCY RANGE CALIBRATION OSCILLATOR SECTION	152-174 mc	152-174 mc
FREQUENCY RANGE WWV RECEIVER	10 & 15 mc	5 & 10 mc
TUBE COMPLEMENT AND FUNCTION	6AK5 - R-F Amplifier 12AT7 - Oscillator/Mixer 6BE6 - Converter 6BJ6 - 1st I-F	6BJ6 - 2nd I-F 6AT6 - Det. - A-F Amplifier - Osc. 6AQ5 - Audio Output OB2 - Voltage Regulator

CONTROL SETTINGS FOR ALIGNMENT OF WWV RECEIVER SECTION

CONTROL	POSITION
ON-OFF	ON
XTAL HEATER	OFF
CALIB	WWV REC
WWV-AF GAIN	ON

STEP	STAGE, TEST CONDITION, AND PROCEDURE	ALIGNMENT FREQUENCY	ADJUSTMENT	METER READING
1	2ND IF - Disconnect the WWV antenna for all of the following alignment procedures. With the DB METER switch in the MONITOR position, apply the 1.75 mc, modulated 30% with a 400 cycle tone output of the signal generator to pin 1 of V3 (2nd IF 6BJ6). Alternately adjust i-f coils L8 and L9 until a maximum meter reading is obtained on the MODULATION DEVIATION meter.	1.75 mc Mod. 30% 400 cycle tone	L8 and L9	Maximum
2	1ST IF - With the DB METER switch in the MONITOR position, apply the 1.75 mc modulated 30%, with a 400 cycle tone output of the signal generator to pin 1 of V2 (1st IF 6BJ6). Alternately adjust i-f coils L6 and L7 until a maximum meter reading is obtained on the MODULATION DEVIATION meter.	1.75 mc Mod. 30% 400 cycle tone	L6 and L7	Maximum
3	CONVERTER - With the DB METER switch in the MONITOR position, apply the 1.75 mc modulated 30%, with a 400 cycle tone output of the signal generator to the WWV antenna input marked LZ. Alternately adjust i-f coils L4 and L5 for a maximum meter reading on the MODULATION DEVIATION meter.	1.75 mc Mod. 30% 400 cycle tone	L4 and L5	Maximum
4	WWV OSCILLATOR - 5 and 10 mc - The previous i-f alignment should be completed before aligning the WWV oscillator. Connect the output of the signal generator to the LZ antenna input connector, J2. Tune the signal generator output to 5 mc modulated 30% with a 400 or 1000 cps tone. Place the WWV-SEL switch to position A, and the WWV-TUNE control to its mid-position. With the DB METER switch in the LINE position adjust the tuning slug of the oscillator coil, L3L, until the modulated tone is heard in the speaker. Set the DB METER switch to the MONITOR position, and adjust coil L1L for a maximum meter reading on the MODULATION DEVIATION meter. Set the frequency of the signal generator to 10 mc, modulated 30% with 400 or 1000 cps, and place the DB METER switch in the LINE position. Adjust the trimmer capacitor, C10, until the modulated signal is heard in the speaker. Set the DB METER switch to the MONITOR position, and adjust coil L2 for a maximum meter reading on the MODULATION DEVIATION meter.	5 and 10 mc Mod. 30% 400 or 1000 cycle tone	L3L, L1L, C10 and L2	Maximum
	WWV OSCILLATOR - 10 and 15 mc - The previous i-f alignment should be completed before aligning the WWV oscillator. Place the WWV-SEL switch to position B, and the WWV-TUNE control to its mid-position. Connect the output of the signal generator to the LZ antenna input connector, J2. Tune the signal generator output to 10 mc, modulated 30% with a 400 or 1000 cps tone. With the DB METER switch in the LINE position, adjust the tuning slug of the oscillator coil L3H until the modulated tone is heard in the speaker. Set the DB METER switch to the MONITOR position, and adjust coil L2 for a maximum meter reading on the MODULATION DEVIATION meter. Place the WWV-SEL switch in position A, DB METER switch in the LINE position and tune the signal generator to 15 mc modulated 30% with a 400 or 1000 cps tone. Adjust the trimmer capacitor C10 until the modulated signal is heard in the speaker. Set the DB METER switch to the monitor position, and adjust coil L1H for a maximum meter reading on the MODULATION DEVIATION meter.	10 and 15 mc Mod. 30% 400 or 1000 cycle tone NOTE On 15 mc adjust osc (C10) below carrier (13.25 mc)	L3H, L1H, C10, and L2	Maximum
5	CALIBRATING OSCILLATOR SECTION: OSCILLATOR - Since this stage is crystal controlled, there is no alignment necessary. RF AMPLIFIER - SENSITIVITY IMPROVEMENT - The transmitted carrier can be used for this adjustment providing providing the frequency has been checked and proven correct. Place the MON CHANNEL SEL switch to the appropriate channel to be monitored. Set the METERING switch to position 2, and the SELECTOR switch to the 0-20 KC M.D. position. Turn the transmitter on, and adjust TU1, TU2, and TU3 for a maximum meter reading on the CARRIER FREQUENCY meter. (These adjustments must be made through the tuning holes in the front panel.) If a maximum tuning indication cannot be obtained with the METERING switch in position 2, switch to position 1, and adjust TU1, TU2, and TU3 until a definite peak is obtained.	Transmitted Carrier	TU1, TU2 and TU3	Maximum



FRONT VIEW OF MON. CHANNEL SELECTOR SWITCH S-2
LUG VIEW OF MON. CHANNEL SELECTOR SWITCH S-2
FRONT VIEW OF WWV SELECTOR SWITCH S-1
LUG VIEW OF WWV SELECTOR SWITCH S-1
LUG VIEW OF CALIBRATION SWITCH S-4
FRONT VIEW OF CALIBRATION SWITCH S-4

NOTES
1. ALL RESISTOR VALUES ARE INDICATED IN OHMS AND ARE ±10% OR MORE, 1/2 WATT OR LESS UNLESS OTHERWISE STATED. K=1000.
2. ALL CAPACITOR VALUES ARE INDICATED IN MICROMICROFARADS UNLESS OTHERWISE STATED
3. WHEN WWV SIGNALS ARE WEAK REMOVE JUMPER JU-1 IN ORDER TO ZERO BEAT SIGNAL WITH OSCILLATOR. JU-1 IS LOCATED NEXT TO WWV ANT. L2 ON WIRING SIDE OF CHASSIS
4. COMPONENTS WITH L DESIGNATION USED FOR 5 & 10 MC OPERATION. COMPONENTS WITH H DESIGNATION USED FOR 10 & 15 MC OPERATION.

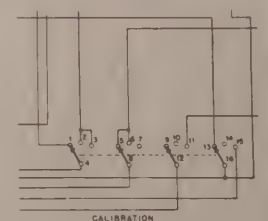
DIAGRAM NO 63E862217

MODEL TABLE

MODEL	SUFFIX	DESCRIPTION	FREQUENCY
TRD1060A	4	WWV RECEIVER	10-15MC
TRD1070A	4	WWV RECEIVER	5-10MC

REVISIONS

DIAG ISSUE	BOARD AND SUFFIX NO	REF SYMBOL	CHANGE	LOCATION
	TRD1060A-1 TRD 070A 1		RESISTOR ADDED, CIRCUIT WAS AS SHOWN BELOW	CONTACT 7 OF S4
P	TRD1060A-2 TRD1070A-2	C2 C8L C8H	WAS 20 uuf WAS 125 uuf WAS 175 uuf	WWV SELECTOR SWITCH S1
C				
C	TRD1060A-3 TRD1070A-3			
D				



Models TRD1060A and TRD1070A
WWV Receiver
Schematic Diagram
Motorola No. 63E862217-D
10/13/61-RCS

PARTS LIST for Schematic Diagram 63E862217-D

TRD1060A CALIBRATING OSCILLATOR AND (10-15 mc) WWV RECEIVER (152-174 mc)
TRD1070A CALIBRATING OSCILLATOR AND (5-10 mc) WWV RECEIVER (152-174 mc)

1. P-7215-A Calibrating Oscillator and WWV Receiver (Basic Chassis)

REFERENCE SYMBOL	MOTOROLA PART No.	DESCRIPTION
		CAPACITOR, fixed: ±10%; 500 vdcw; unless otherwise stated
C1H		see COIL KIT section
C1L		see COIL KIT section
C2		see COIL KIT section
C3	21K85884	ceramic; 18 uuf ±.5 uuf
C4	21K840845	ceramic; disc; 24 uuf ±5%
C5	19A893091	variable: air; 4 uuf min. to 12 uuf max.; WWV TUNE
C6	21B401029	ceramic; disc; .02 uf +80-20%; 600 vdcw
C7		same as C6
C8H		see COIL KIT section
C8L		see COIL KIT section
C9		see COIL KIT section
C10	20A800192	variable: air 7 uuf min. to 45 uuf max.
C11		same as C6
C12		see COIL KIT section
C13		see COIL KIT section
C14		see COIL KIT section
C15	21K881064	molded phenolic; tubular; .15 uuf ±5%
C16		same as C6
C17	21K837746	ceramic; disc; .002 uuf
C18		same as C6
C19		see COIL KIT section
C20		see COIL KIT section
C21		see COIL KIT section
C22		same as C6
C23	21K77267	ceramic; 1.5 uuf ±.3 uuf
C24		same as C6
C25		same as C6
C26		see COIL KIT section
C27		see COIL KIT section
C28		same as C6
C29	21K847087	mica; 220 uuf ±10%; 300 vdcw
C30		same as C23
C31		NOT USED
C32	8A890585	oil filled; .05 uf; 400 vdcw
C33	21K864736	1300 uuf ±5%; 500 vdcw
C34	21K874354	mica; 5100 uuf ±5%; 300 vdcw
C35	21R6568	mica; 2000 uuf
C36	21R2745	220 uuf ±20%, 300 vdcw
C37	21R6591	mica; 220 uuf
C38	21R6649	mica; 150 uuf
C39	23B893368	electrolytic; 20 uf +100-10%; 25 vdcw
C40		same as C34
C41	21R6630	1000 uuf ±20%; 300 vdcw
C42		same as C6
C43	8K891049	molded; .36 uuf
C44	21K873269	mica; 820 uuf; 300 vdcw
C45	21R6678	820 uuf; 300 vdcw
C46	19K800728	variable: air; 4 uuf min. to 14 uuf max.
C47		see R-F DECK section
C48		see R-F DECK section
C49		see R-F DECK section
C50		see R-F DECK section
C51		same as C37
C52		see R-F DECK section
C53		see R-F DECK section
C54		see R-F DECK section
C55		see R-F DECK section
C56		see R-F DECK section
C57		see R-F DECK section
C58		see R-F DECK section
C59		see R-F DECK section
C60		see R-F DECK section
C61		see R-F DECK section
C62		see R-F DECK section
J1	9C87120	CONNECTOR, receptacle: female; single contact; HZ WWV ANTENNA
J2		same as J1 except LZ WWV ANTENNA
J3		see R-F DECK section
J4		see R-F DECK section
L1H		COIL, see COIL KIT section
L1L		see COIL KIT section
L2		see COIL KIT section
L3H		see COIL KIT section
L3L		see COIL KIT section
L4		see COIL KIT section
L5		see COIL KIT section
L6		see COIL KIT section
L7		see COIL KIT section
L8		see COIL KIT section
L9		see COIL KIT section
L10		see COIL KIT section
L11		see R-F DECK section
L12		see R-F DECK section
L13		see R-F DECK section
P1	28B813576	CONNECTOR, receptacle: male; 11 contact; polarized; does not include 42A821428 RING, retainer; ring must be ordered separately
R1	6R6397	RESISTOR, fixed: carbon; ±10%; 1/2 w; ins.; unless otherwise stated 22K
R2	6R6497	3.3 megohm
R3		same as R1
R4		see COIL KIT section
R5		see COIL KIT section
R6	6R6432	270 ohm
R7	6R6407	220K
R8		see COIL KIT section
R9		see COIL KIT section
R10	6R5660	180 ohm
R11		same as R7
R12		see COIL KIT section
R13		see COIL KIT section
R14	6R6046	1 megohm
R15	6R6430	10K; 1 w
R16	18A893092	variable: 1 megohm ±20%; includes S3
R17	6R6031	100K
R18		same as R14
R19	6R5593	470 ohm; 1 w
R20	6R5622	10 megohm
R21	6R6398	150K
R22		same as R7
R23	6R6377	470K
R24	6R5697	560K
R25	6R5765	5.6K; 2 w
R26		see R-F DECK section
R27		see R-F DECK section
R28		see R-F DECK section
R29		see R-F DECK section
R30		see R-F DECK section
R31		see R-F DECK section
R32		see R-F DECK section
R33		see R-F DECK section
R34		see R-F DECK section
R35	17K892469	wire-wound; 4 ohm ±2%; 1 w
S1	40B893093	SWITCH, rotary: 4 pole; 2 position; WWV SELECTOR
S2	40K893095	2 pole; 6 position; MON CHANNEL SELECTOR
S3		spst; p/o R16
S4	40K893094	4 pole; 3 position; CALIBRATION
T1	25B834267	TRANSFORMER, AF: output; primary; 2500 ohms at 10 V RMS with 40 ma. d-c; secondary; 3.2 ohm
V1	195T103A01	TUBE, electron: type 6BE6
V2	195T176A01	type 6BJ6
V3		same as V2
V4	195T213A01	type 6AT6
V5	195T101A01	type 6AQ5
V6	195T205A01	type OB2
V7		see R-F DECK section
V8		see R-F DECK section
XV1	9B87123	SOCKET, tube: female; 7 contact; miniature; molded black phenolic base
XV2		same as XV1
XV3		same as XV1
XV4		same as XV1
XV5		same as XV1
XV6		same as XV1
XV7		see R-F DECK section
XV8		see R-F DECK section
XY1	9K82810	SOCKET, crystal: female; 2 contact; black phenolic base
XY2		same as XY1
XY3		same as XY1
XY4		same as XY1
XY5		same as XY1
XY6	9K857508	4 contact; molded black bakelite base; chassis mounted

2. K-7214 Coil Kit (10-15 mc)

REFERENCE SYMBOL	MOTOROLA PART No	DESCRIPTION
		CAPACITOR, fixed: ±5%; 500 vdcw; unless otherwise stated
C1H	21R35390	ceramic; 39 uuf; p/o L1H
C2	21K865368	ceramic; 12 uuf; p/o L2
C8H		NOT USED
C9	21K852322	silver mica 62 uf; ±5%, 500 v
C12	21R474573	ceramic; 50 uuf; p/o L4
C13	21K838729	ceramic; disc; 51 uuf; 250 vdcw; p/o L5
C14	21K840046	dipped silver mica; 100 uuf ±10%; p/o L5
C19		same as C12 except p/o L6
C20		same as C13 except p/o L7
C21		same as C14 except p/o L7
C26		same as C12 except p/o L8
C27		same as C12 except p/o L9
L1H	24B893082	COIL, R-F: WWV Antenna; 15 mc
L2	24K868994	R-F: B09; WWV Antenna; 10 mc
L3H	1V80707A15	R-F: Oscillator; 1.25 micro-henries
L4	24B86890	I-F: Convertor Plate
L5	24K800519	I-F: 1st I-F Grid
L6		same as L4 except 1st I-F Plate
L7	24B86888	I-F: 2nd I-F Grid
L8		same as L4 except 2nd I-F Plate
L9	24B893073	A-F: Detector and 1st A-F Low Frequency Oscillator
L10	24A893067	COIL, (cont'd) R-F: Choke 1.6 microhenries
R4	6R6080	RESISTOR, fixed: carbon; ±10%; 1/2 w; ins.; unless otherwise stated 4.7K; p/o L4
R5	6R6046	1 megohm; p/o L5
R8		same as R4 except p/o L6
R9	6R6031	100K; p/o L7
R12		same as R4 except p/o L8
R13	6R6074	68K; p/o L9

3. K-7214-A Coil Kit (5-10 mc)

REFERENCE SYMBOL	MOTOROLA PART No	DESCRIPTION
		CAPACITOR, fixed: ±10%; 500 vdcw; unless otherwise stated
C1L	21K840045	ceramic; 62 uuf; p/o L1L
C2	21K865368	ceramic; 12 uuf ±5%; p/o L2
C8L	21K848978	silver mica; 190 uuf ±3%, 500 v
C9	21K852322	silver mica; 62 uf ±5%, 500 v
C12	21R474573	ceramic; 50 uuf ±5%; p/o L4
C13	21K838729	ceramic; disc; 51 uuf ±5%; 250 vdcw; p/o L5
C14	21K840046	dipped silver mica; 100 uuf; p/o L5
C19		same as C12 except p/o L6
C20		same as C13 except p/o L7
C21		same as C14 except p/o L7
C26		same as C12 except p/o L8
C27		same as C12 except p/o L9
L1L	24B893070	COIL, R-F: WWV Antenna; 5 mc
L2	24K868994	R-F: B09, WWV Antenna; 10 mc
L3L	1V80707A15	R-F: Oscillator; 1.25 micro-henries
L4	24B86890	I-F: Convertor Plate
L5	24K800519	I-F: 1st I-F Grid
L6		same as L4 except 1st I-F Plate
L7	24B86888	I-F: 2nd I-F Grid
L8		same as L4 except 2nd I-F Plate
L9	24B893073	A-F: Detector and 1st A-F Low Frequency Oscillator
L10	24A893067	COIL, (cont'd) R-F: Choke; 1.6 microhenries
R4	6R6080	RESISTOR, fixed: carbon; ±10%; 1/2 w, ins.; unless otherwise stated 4.7K; p/o L4
R5	6R6046	1 megohm; p/o L5
R8		same as R4 except p/o L6
R9	6R6031	100K; p/o L7
R12		same as R4 except p/o L8
R13	6R6074	68K; p/o L9

4. P-7217 R-F Deck (152-174 mc)

REFERENCE SYMBOL	MOTOROLA PART No	DESCRIPTION
		CAPACITOR, fixed: ±10%; 500 vdcw; unless otherwise stated
C47	21K840711	dipped silver mica; 51 uuf ±5%
C48	21K831125	ceramic; disc; 100 uuf
C49	21R83202	ceramic; 39 uuf ±2%
C50	21R54877	ceramic; 15 uuf ±5%
C51		see BASIC CHASSIS section
C52	21R115312	ceramic; 5000 uuf +100-0%
C53	21K859601	ceramic; 1000 uuf ±20%; 600 vdcw
C54		same as C53
C55	21K840845	ceramic; disc; 24 uuf ±5%
C56		part for TU1; field replacement not recommended
C57		same as C55
C58		part for TU2; field replacement not recommended
C59	21K881064	CAPACITOR, (cont'd) molded phenolic; tubular; .15 uuf ±5%
C60		same as C58 except part for TU3 and field replacement not recommended
C61		same as C55
J3	9C87120	CONNECTOR, receptacle: female; single contact; RECEIVER
J4		same as J3 except ANTENNA
L11	24A801463	COIL, R-F: choke; .22 microhenries
R26	6R6048	RESISTOR, fixed: carbon; ±10%; 1/2 w; ins.; unless otherwise stated 47K
R27	6R6431	15K; 1 w
R28	6R6397	22K
R29	6R6320	10K
R30	6R6031	100K
R31	6R6377	470K
R32	6R6497	3.3 megohm
R33		same as R30
R34	6R6046	1 megohm
TU1		CAVITY, Field Replacement Not Recommended
TU2		Field Replacement Not Recommended
TU3		Field Replacement Not Recommended
V7	195T113A01	TUBE, electron: type 12AT7
V8	195T170A01	type 6AK5
XV7	9B86868	SOCKET, tube: female; 9 contact; miniature; molded black phenolic base
XV8	9K87124	female; 7 contact; miniature; molded mica filled base

5. Crystal

NOTE

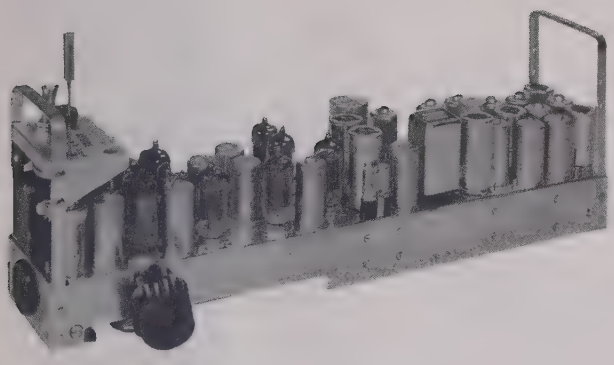
Crystal Units are part of the Radio Set model. When ordering a receiver chassis only, crystals must be ordered separately.

Crystal type number and operating frequency must be specified when ordering crystal.

REFERENCE SYMBOL	MOTOROLA PART No.	DESCRIPTION
Y1	Type SFMT-2	CRYSTAL UNIT, quartz: Channel Crystal
Y2		same as Y1
Y3		same as Y1
Y4		same as Y1
Y5		same as Y1
Y6	Type R11	Receiver Control

MOTOROLA

CONTROL RECEIVER



TRD1080A RECEIVER

1. INTRODUCTION

The Model TRD1080A and TRD1090A Control Receivers described in this text are designed for specific use in the Motorola FM Station Monitor, which operates in the 150.8-174 mc range. The receivers are of the FM double superheterodyne type designed for reception of carrier signals with ±15 kc maximum deviation. When monitoring stations in the 150.8-174 mc range, the control receiver will be aligned to either 150 mc, 155 mc, 160 mc, or 170 mc as explained in the INSTALLATION & OPERATION section of this instruction manual.

2. DESCRIPTION

The TRD1080A Receiver is a strip design chassis comprised of the following units.

- TRD6020A Basic Chassis which uses a Type R15 Control Crystal, a type A07 IF Crystal, and includes a K-9014-F Coil Kit
- TFN6004AX Filter

The Model TRD1090A Receiver is essentially the same as the Model TRD1080A Receiver, except that it is aligned to 170 mc to monitor the frequencies in the higher end of the vhf band. Alignment is identical to the Model TRD1080A, except for the calibration frequency.

The TRD1090A Receiver comprises the following units:

- TRD6020A Basic Chassis with a type R15 or R38 Control Crystal, a type A07 or A18 IF Crystal and TJD6010A Coil Kit
- TFN6004AX Filter

3. PRE-OPERATIONAL NOTES

a. Control Receiver Frequency Check

The receiver is aligned to its exact operating frequency prior to shipment from the factory. It should, however, be checked for proper operation before it is placed in service. If the receiver frequency is beyond the allowable limits, realign the receiver according to the alignment chart.

b. Sensitivity Adjustment (20 db Quieting)

The receiver sensitivity check should be made in a well shielded location in the absence of extraneous electrical noise. The sensitivity, or quieting signal, is that input signal necessary to reduce the output noise at the speaker by 20 db.

The following equipment is required to accurately measure the quieting signal:

Signal Generator (Motorola Model T1034B, or equivalent)

Motorola S1056A-9A or TU546 Series Test Set (or equivalent)

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PERFORMANCE SPECIFICATIONS

BASIC UNIT	TRD1080A or TRD1090A
FREQUENCY	150 mc, 155 mc, 160 mc, or 170 mc
POWER INPUT	6.3 v a-c at 4 a 185 v d-c at 55 ma
TUBE COMPLEMENT AND FUNCTION	6AK5 1st RF Amplifier 6AK5 2nd RF Amplifier 6J6 Oscillator & Multiplier 6AK5 1st Mixer 6CB6 2nd Mixer 6C4 2nd Oscillator 6BH6 2nd IF-1 6BH6 2nd IF-2 6BH6 2nd IF-3 6BH6 2nd IF-4 6BH6 1st Limiter 6AK6 2nd Limiter 6BG7 Discriminator 6BH6 Noise Amplifier 6BG7 Noise Rectifier 12AX7 Audio and Squelch 6AK6 Power Amplifier
TUNED CIRCUITS	Eleven permeability tuned circuits in the IF amplifier stages, including three in the IF Filter Replacement Kit.
METERING	A Motorola S1056A-9A or TU546 Series Test Set (or equivalent) microampere meter may be used for this application. One side of the meter should be connected to chassis ground, and the other to one of the pins of the metering socket, located on the receiver chassis, corresponding to the desired circuit to be measured.

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

(1) Warm up the signal generator for 1-1/2 to 2 hours.

(2) Plug the test set metering cable into the test set and the other end into the 11-pin receiver metering socket on the radio set.

(3) Place the test set function selector switch in the RCVR position. Place the position selector in position 11, AUDIO.

(4) Set the signal generator to the carrier frequency and connect the signal generator, using the coaxial cable and 6 db pad, to the antenna connector on the radio set. The exact carrier frequency will be indicated by a "0" reading on the "0" center scale of the test set with the position selector switch in position 4. Return the switch to position 11, AUDIO.

(5) Turn the SQUELCH control on the control head fully counterclockwise (open).

(6) Set the VOLUME control to provide any convenient reading on the 0-2 v a-c scale on the test set, preferably mid-scale for ease in reading.

(7) If the radio set has a speaker connected to it and in operation, place the test set SPKR switch to the OPEN position. If the radio set under test does not have a speaker connected to it, place the test set SPKR switch to the LOAD position. It is important that only one speaker be in the circuit, i.e., either the speaker on the monitor or the speaker on the test set. Now note the exact meter reading and mark it down for use as a reference later.

(8) Place the test set multiplier switch to the 0.2 v a-c position and hold it there. This makes the meter exactly 10 times, or 20 db, more sensitive than the normal 2 v a-c position.

(9) Increase the signal until the meter needle is in exactly the same position as noted in step (7). The noise has been reduced 20 db. The receiver sensitivity in microvolts can now be read on the signal generator.

c. Alignment Methods

(1) Alignment Procedure Using a Motorola Portable Test Set

A complete receiver alignment procedure, in chart form, is included in this section. Test set up information, using a Motorola portable test set, and front panel control settings, are also supplied with the alignment procedure.

NOTE

The Motorola S1056A-9A or TU546 Series Test Set (or equivalent) has a factory installed 455 kc crystal. A 457 kc crystal must be ordered from the factory to align the Control Receiver in this equipment. Plug the 457 kc crystal in the position A crystal socket inside the test set.

(2) Alignment Procedure Using Carrier Frequency Meter and Metering Switch

When using the front panel facilities for alignment, disconnect the cable plug from the ANT connector on the Control Receiver chassis. This cable connects between the REC connector on the WWV Receiver and the ANT connector on the Control Receiver. All other connections can remain as they are connected in normal operation. The procedure for actual alignment is the same as outlined in the alignment chart (EPD-2084) of this section, however, the meter readings will not be the same as for the portable test set. The Control Receiver circuits should be adjusted for a peak reading on the CARRIER FREQUENCY meter, SELECTOR switch in 0-20 KC. M.D. position while maintaining the signal generator output for a reading of 3.5 microamperes or less with the METERING switch in position 2. The DISCRIMINATOR ZERO SET adjustment should be adjusted for a center scale reading (0) on the CARRIER FREQUENCY meter. A table listing METERING switch positions and Control Receiver circuits being checked is included on Pages 1 and 2 of the INSTALLATION and OPERATION section of the instruction manual.

HOW TO SET UP THE P-8500 AND P-8501 SERIES TEST SETS FOR DISCRIMINATOR AND 457 KC ALIGNMENT

1. Set the REC.-XMTR. 0-50 UA switch to the REC position.
2. Plug a 457 kc crystal into the two-pin crystal socket.
3. Set the GRID CURRENT-METER-FIELD STRENGTH selector switch to the GRID CURRENT position.
4. Set the ATTENUATOR control for maximum output (10).
5. Place the test set ON-OFF switch in the ON position. (Test set operates on internal battery. Conserve battery life by keeping switch OFF when set is not in use.)
6. Adjust the frequency control (ADJ) for a maximum meter reading.
7. Set the ON-OFF switch to the OFF position.
8. Set the GRID CURRENT-METER-FIELD STRENGTH switch to the METER position.
9. Plug the test set metering cable into the METER receptacle on the receiver chassis.
10. Connect one end of the test set extension cable to the RF OUTPUT jack on the test set. Connect the other end of the extension cable to the RF probe cable.

HOW TO SET UP THE TU546 SERIES TEST SETS FOR DISCRIMINATOR AND 457 KC ALIGNMENT

1. Set the function selector switch to the RCVR position.
2. Connect the 20 pin metering cable into the receptacle on the test set. Plug the other end (11 pin) into the metering socket on the receiver.
3. Connect one end of the test set rf extension to the rf connector on the test set. Connect the other end of the extension cable to the rf probe cable.
4. Place the oscillator and meter reversing switch to position A (457 Kc).

TEST SET SELECTOR SWITCH POSITIONS

P-8500 & P-8501 SERIES TEST SETS	1	2	+4, -4	5	6
TU546 SERIES TEST SETS	1	2	4	5	6
CIRCUIT METERED	2nd I-F #3 Grid	1st Lim. Grid	Discr. Output	Discr. Input	1st Osc. Grid

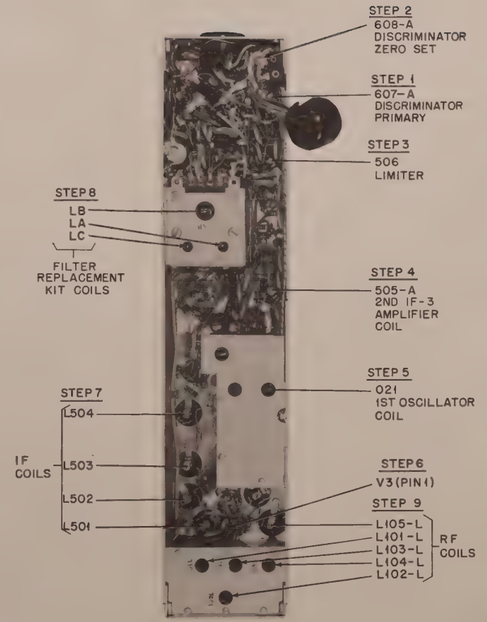
FRONT PANEL CONTROL SETTINGS

CONTROL	SETTING
WWV-AF GAIN	OFF
METERING	4
CALIB	MOD TEST NORMAL
DB METER	LINE
MON CHANNEL SEL	DISC CALIB
SELECTOR	0-20 KC, M.D.

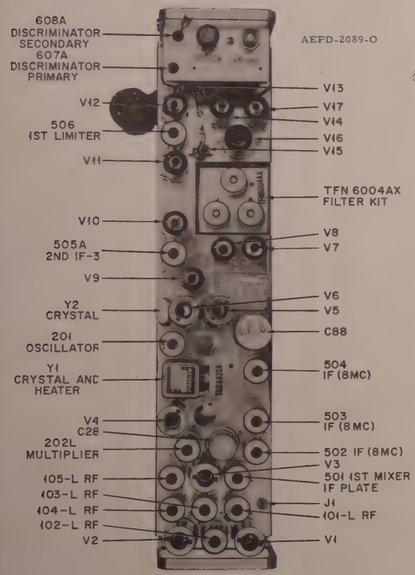
HOW TO SET UP THE SIGNAL GENERATOR* FOR 8 MC IF ALIGNMENT

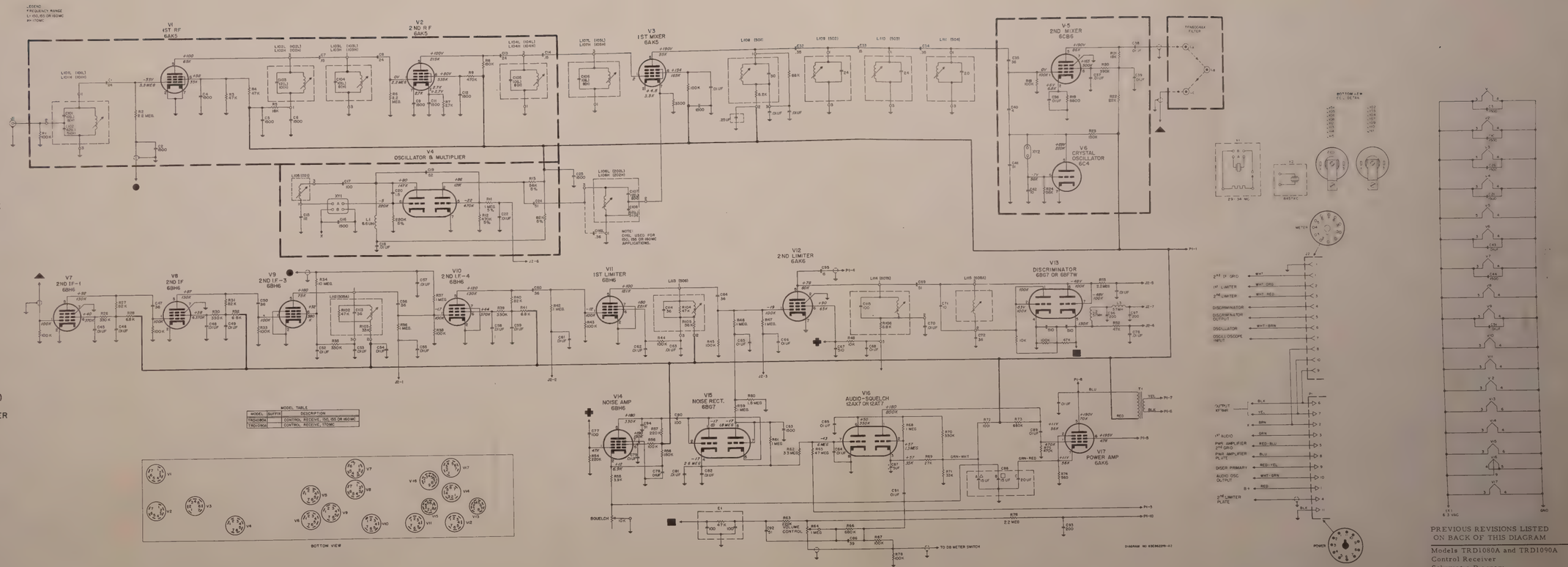
1. Couple the signal generator output loosely to the grid (pin 7) of V-3. Couple just enough input to give a small meter reading.
2. Set the test set selector switch to position 4. Turn on test set.
3. Set the signal generator frequency for approximately 8 mc.
4. Locate the exact 8 mc point by rotating the generator dial back and forth around the 8 mc setting until you obtain a meter reading of exactly zero (position 4). The meter reading should go above and below zero as the dial is rotated. Leave the generator set for zero meter reading. Make sure the signal remains constant throughout the alignment (generator may drift).

*Use Motorola Model T1034B, or equivalent.



STEP	STAGE, TEST CONDITIONS, AND PROCEDURE	ALIGNMENT FREQUENCY	ADJUSTMENT	TU546 TEST SET SWITCH POSITION	METER READING
1	DISCRIMINATOR PRIMARY- Detune the discriminator secondary by turning the DISCRIMINATOR ZERO SET control fully counterclockwise. Lay the RF probe under the receiver chassis near pin 1 of tube V-7. Adjust the discriminator primary coil 607-A for maximum meter reading with meter switch in position 5.	457 kc, sharp tuning	607-A	5	Maximum
2	DISCRIMINATOR SECONDARY- With the RF probe in the same place as in step 1., adjust the DISCRIMINATOR ZERO SET for a zero meter reading with meter switch in position 4.	457 kc, sharp tuning	Discriminator Zero Set	4	Zero
3	LIMITER - With the RF probe in the same place as in step 1, adjust limiter coil 506 for maximum meter reading with the meter switch in position 3. Reduce the output of the signal generator for an unsaturated meter reading with meter switch in position 2. A meter reading of less than 10 micro-amperes is satisfactory.	457 kc, sharp tuning	506	2	Maximum
4	2ND. IF -3 AMPLIFIER - With the RF probe in the same place as in step 1, adjust the 2nd. IF-3 Amplifier coil 505-A for maximum meter reading with the meter switch in position 1.	457 kc, broad tuning	505-A	1	Maximum
5	1ST. OSCILLATOR COIL- Place the meter switch in position 6, and note if the meter shows the presence of oscillation. If there is no reading, adjust the oscillator warping coil 021 until the meter indicates oscillation. Place the MON CHANNEL SEL switch in the DISC CALIB position. Connect the output from the Calibrating Oscillator to the input of the receiver, and adjust the oscillator warping coil 021 for a zero meter reading with the meter switch in position 4.	457 kc, sharp tuning	Coil 021	4	Zero
6	1ST. IF COIL- Connect the output of the RF signal generator, 8 megacycles, to the grid (Pin 1) of V-3, the 1st. mixer stage by means of a coaxial cable with resistive termination (50 ohms impedance, 50 ohm termination. Measurements Corporation Part No. 84-Z2-2, or equivalent). Tune the signal generator to the exact frequency, indicated by a zero meter reading, with the meter switch in position 4.	8 mc, sharp tuning		4	Zero
7	IF COILS 504, 503, 502, and 501 - With the signal generator output connected as in step 6, adjust IF coils 504, 503, 502 and 501, in that order, for maximum meter reading with the meter switch in position 1 or 2 (position 2 being the most sensitive). Keep the output level of the signal generator at a point less than 10 micro-amperes, with the meter switch in position 2.	8 mc, sharp tuning	504, 503, 502, 501	1 or 2	Maximum
8	FILTER REPLACEMENT KIT COILS L_A, L_B, AND L_C - Adjust coils L_A, L_B, and L_C, for maximum meter reading with the meter switch in either position 1 or 2, remembering to keep the output of the signal generator, low so as not to exceed a 10 micro-ampere reading on the meter.	8 mc, sharp tuning	L_A, L_B, and L_C	1 or 2	Maximum
9	RF COILS- Connect the output of the signal generator, adjusted to the desired control receiver frequency, to the antenna connector on the receiver by means of the coaxial cable (50 ohm impedance) and Measurements Corporation output matching pad, Part No. 80ZH-3 (6 db loss) or equivalent. Adjust the signal generator to obtain zero meter reading with the meter switch in position 4. Adjust coils 105-L, 104-L, 103-L, 102-L, 101 and multiplier coil 202-L for a maximum meter reading, with the meter switch in position 1 or 2.	Control Receiver frequency, sharp tuning	105-L, 104-L, 103-L, 102-L, 101 and 202-L	1 or 2	Maximum





PREVIOUS REVISIONS LISTED ON BACK OF THIS DIAGRAM

Models TRD1080A and TRD1090A
Control Receiver
Schematic Diagram
Motorola No. 63E862219-A2
11/11/66-RCS

SQUELCH RELAY KIT

1. DESCRIPTION

The TLN6037A Squelch Relay Kit is a vacuum tube operated relay. The unit consists basically of an electronic circuit, utilizing a Type 5963 duo-triode tube and d-c type relay, assembled onto a small compact sized sub-chassis.

This kit is designed for use in Motorola FM Station Monitor to provide a positive indication that an r-f carrier is being received. This indication is in the form of a GREEN "CARRIER-ON" lamp on the front panel which is illuminated when a carrier of sufficient strength for proper monitoring is received. A SENSITIVITY control is provided on the squelch kit to set the point of relay operation. Adjustment of this control permits the relay to pull in with signal levels sufficient to provide from 8 to 26 db of noise quieting (See paragraph 3 for proper adjustment.)

2. INSTALLATION

a. Installation in FM Station Monitors (where the three pin female receptacle is located on the relay kit mounting bracket)

(1) Use a 0.166" diameter drill and drill two holes as follows:

(a) Locate the first hole 1" from the top of the side panel and 1-1/16" from the inside curved surface of the right side panel (1-1/8" from the back of the front panel).

(b) Locate the second hole in line with the first hole (1" from the top) and 1-1/8", center to center, from the first hole.

(2) Place the squelch relay on the inside of the right side panel of the station monitor, the adjustable resistor of the squelch relay pointing toward the front panel.

(3) With the two mounting lock screws supplied, mount relay to the side panel. Tighten screws securely.

(4) Connect the three pin male plug from the station monitor to the three pin receptacle on the back side of the relay kit as viewed from the rear.

(5) Connect the three pin male connector from the relay to the three pin receptacle located on the relay kit mounting bracket of the station monitor.

b. Installation in FM Station Monitors (where the three pin female receptacle is a termination of a cable)

(1) Mounting holes for the new relay kit have been drilled and are located in the top front corner of the side panel of the station monitor as viewed from the rear. Refer to steps A(6) and A(7) for mounting details of the relay kit.

(2) Connect the three pin male connector from the station monitor to the three pin receptacle on the back side of the relay kit.

(3) Reconnect the three pin male connector of the relay kit to the three pin female receptacle.

3. ADJUSTMENT

If the TLN6037A Squelch Relay Kit and the FM Station Monitor are shipped as one unit, the

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squelch relay kit requires no adjustment. However, the following information describes the procedure for checking adjustment of the SENSITIVITY control, R3. This control is made accessible by opening the front panel of the station monitor. The SENSITIVITY control is used to set the cutoff bias of the first half of V1 so that relay contact closure occurs at 15 db quieting signal. Refer to Schematic Diagram 63B862139. The quieting signal required is that signal necessary to reduce the output noise at the speaker, 15 db. The actual measurement is made by observing the noise voltage at the speaker without a carrier signal at the antenna. Then sufficient carrier is introduced at the antenna to reduce the output voltage to approximately 1/6 of its former value. With this signal input, adjust the SENSITIVITY control for relay pull-in which produces 15 db quieting. Refer to alignment notes in the UNI-CHANNEL CONTROL RECEIVER section of accompanying manual for quieting signal measurement procedure.

4. OPERATION

Refer to Schematic Diagram 63B862139.

The TLN6037A Squelch Relay Kit is used in the Motorola Frequency Monitor to provide a relay contact closure when an r-f carrier is received. In this kit a type 5963 twin triode vacuum tube is used. This provides a greatly improved performance in circuits where, for a long period of time, very little or no plate current is permitted to flow.

Circuit operation is as follows:

The first half of V1 (5963) is normally conducting in the absence of an r-f carrier as the receiver. With the first half of V1 conducting there is a voltage drop across R4. This places the grid pin 7 at a very low positive voltage and the second half of V1 conducts only slightly. When a negative squelch voltage is applied to the grid of the first half of V1, this section of the tube is driven rapidly towards cut-off. The voltage drop across R4 becomes less, permitting the grid voltage, pin 7, to rise. In turn enough current is now present in the cathode circuit of the second half of V1 to pull-in the relay. Contact closure completes the circuit to the 6.3 v a-c source, energizing the green "CARRIER-ON" lamp on the front panel of the station monitor.

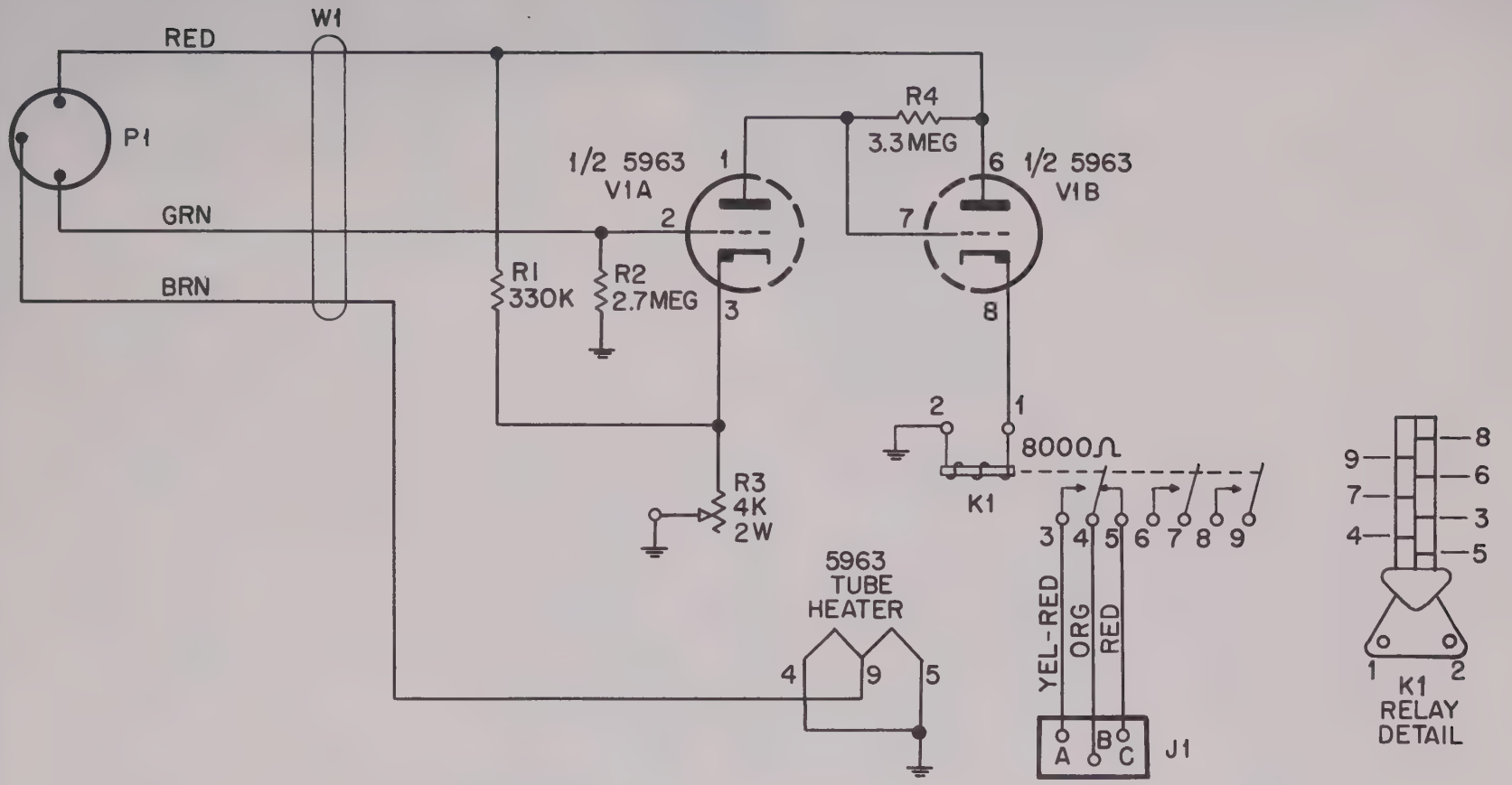


DIAGRAM NO. 63B862139

NOTE:
ALL CONNECTORS SHOWN AS VIEWED FROM WIRING SIDE.

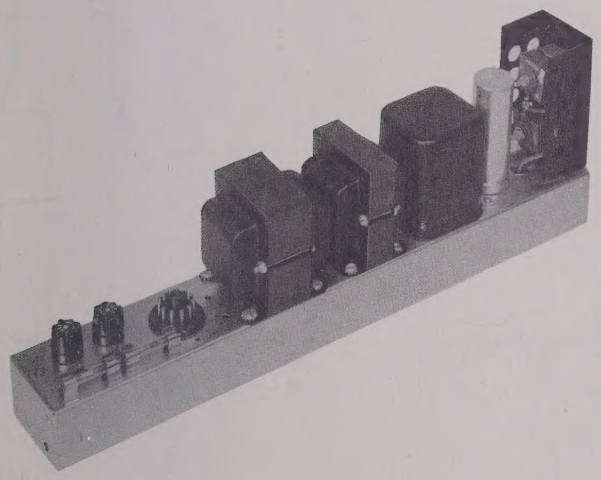
Model TLN6037A Squelch Relay Kit
Schematic Diagram
Motorola No. 63B862139-O
10/25/59-RCS

PARTS LIST for Schematic Diagram 63B862139-O

REFERENCE SYMBOL	MOTOROLA PART No.	DESCRIPTION
		CONNECTOR, receptacle:
J1	9A844394	female; 3 contact; polarized; rectangular bakelite wafer insulator; chassis mounted
		RELAY, armature:
K1	80B837948 or 80K850065	contact arrangement; 1 form "C" and 2 form "A"; 8000 ohm coil; does not include 15A811737 COVER, relay and 7A811735 BRACKET, relay cover; cover and bracket must be ordered separately
		CONNECTOR, plug:
P1	28A16313	male; 3 contact; polarized; round bakelite wafer insulator; cable mounted; does not include 15K801256 SHELL, connector; shell must be ordered separately
		RESISTOR, fixed: carbon: ±10%; 1/2 w; ins.; unless otherwise stated
R1	6R2096	330K
R2	6R488136	2.7 megohm
R3	18K837904	variable: wire-wound; 4K ±20%; 2 w
R4	6R6497	3.3 megohm
		TUBE, electron:
V1	195T197A01	type 5963
		CABLE ASSEMBLY, special purpose:
W1	1V840655	includes miscellaneous wire leads and reference part P1
		SOCKET, tube:
XV1	9B881243	female; 9 contact; miniature; molded black phenolic base; saddle mounting; includes center shield and tube shield base

POWER SUPPLY

MODEL TPN6020AA



TPN6020AA
POWER SUPPLY

1. DESCRIPTION

The TPN6020AA Power Supply provides all of the voltages required for the operation of a Motorola fixed frequency communications receiver, "sensicon" or equivalent. Selenium rectifiers connected for full-wave rectification provide the receiver B+ voltage. Two replaceable, cartridge type fuses provide adequate overload protection of the power circuits. The power supply operates from an a-c power source.

2. THEORY OF OPERATION

The 117 v a-c is applied to this power supply chassis via intercabling and the fuse & junction box which is associated with this radio installation. Leads on pins #6 and #7 of the power supply connector apply the 117 v a-c to the primary windings of transformers T1 and T2. The secondary winding of transformer T1 with a rectifier circuit supplies the d-c voltages required for the operation of an associated receiver in the base station. The secondary winding of transformer T2 provides a 6.3 v a-c source for filament requirements in the receiver.

PERFORMANCE SPECIFICATIONS

BASIC UNIT	TPN6020AA
PRIMARY POWER SOURCE	117 v, 60 cycle, single phase, 2 wire
OUTPUT RATING	200 v d-c at 60 ma 6.3 v a-c at 3.5 a
DIMENSIONS	19" long x 2-1/8" wide x 5-1/4" high
WEIGHT	Approximately 6 lbs.
MOUNTING	Standard 19" Rack

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

MOTOROLA INC. COMMUNICATIONS DIVISION

Engineering Publications 4501 W. Augusta Blvd. Chicago 51, Illinois

10/13/61-RCS 68P862132-B

REVISIONS

DIAG. ISSUE	CHASSIS AND SUFFIX NO.	REF. SYMBOL	CHANGE	LOCATION
01	TPN6020AA	XF1 & XF2	CHANGED PART NO. FROM 9B820279	T1 & T2 PRIMARIES

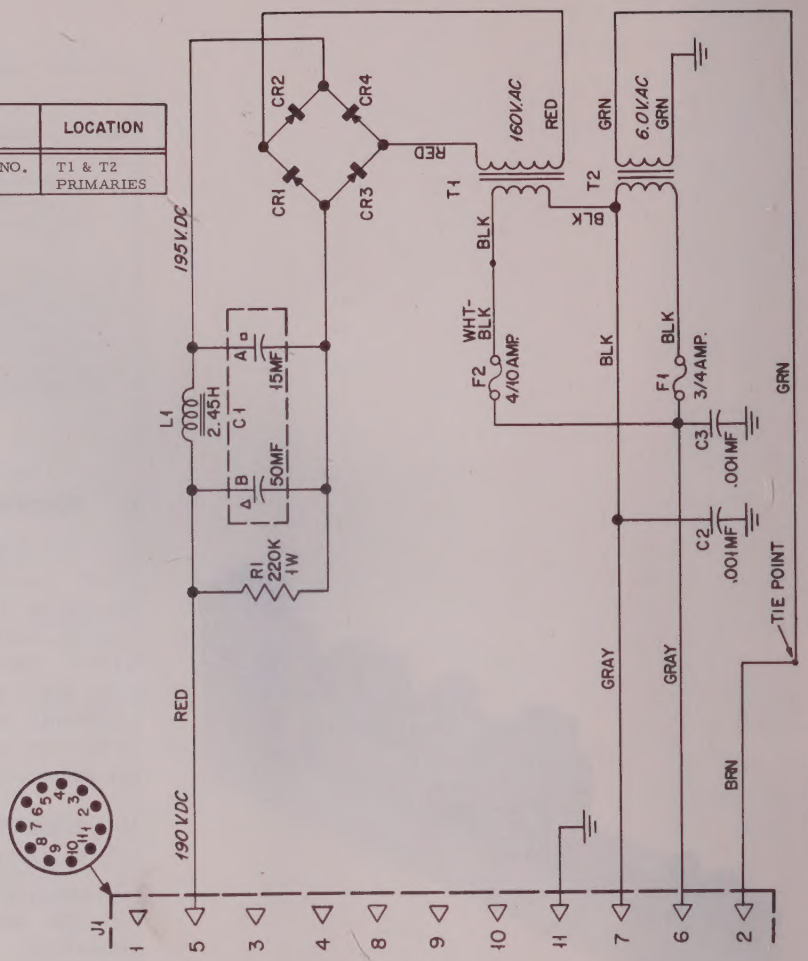


DIAGRAM NO. 63B862133

MODEL TABLE

MODEL	DESCRIPTION
TPN6020AA	A.C. POWER SUPPLY

PARTS LIST for Schematic Diagram 63B862133-O1

REFERENCE SYMBOL	MOTOROLA PART No.	DESCRIPTION
		CAPACITOR, fixed:
C1	23K890493	electrolytic; two sections
C1A		□ 15 uf +50-10%; 350 vdcw
C1B		Δ 50 uf +50-10%; 300 vdcw
C2	21K847601	mica; 1000 uuf ±5%; 500 vdcw
C3		same as C2
		RECTIFIER, metallic:
CR1	48K824141	selenium; 6 plate
CR2		same as CR1
CR3		same as CR1
CR4		same as CR1
		FUSE, cartridge:
F1	65K892099	one time; slow blow; glass; 3/4 amp. 125 volt; 1-1/4" long x 1/4" dia.
F2	65K834465	one time; slow blow; glass; 4/10 amp. 125 volt; 1-1/4" long x 1/4" dia.
J1	28B813576	CONNECTOR, receptacle: male; 11 contact; does not include 42A821428 RING, connector retainer; which must be ordered separately
		COIL, AF:
L1	25K87302	filter; 2.45 henries
		RESISTOR, fixed:
R1	6R5574	carbon; 220K ±10%; 1 w; ins.
		TRANSFORMER, power:
T1	25B813404	plate; primary; 117 volt; 50-60 cps secondary, 190 volts at 55 ma filament;
T2	25B880299	filament; primary; 117 volt; 60 cps secondary 6.3 volt at 4 ampere
		FUSEHOLDER:
XF1	9B82083C01	extractor post type; molded black bakelite bayonet base; single hole chassis mounting; 1-1/4" x 1/4" fuse
XF2		same as XF1

Model TPN6020AA Power Supply
Schematic Diagram
Motorola No. 63B862133-O1
10/13/61-RCS

FM Station Monitor

68P81221O-F